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News and Views from many Sources on Practical Hatchery Problems

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CHANNEL CATFISH CULTURE IN TEXAS

HELPFUL HINTS REGARDING PROPAGATION PROCEDURES

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ALL CHANNEL catfish production in Texas is confined to rearing the southern channel catfish, Ictalurus lacustris punctatus. Some of the hatchery superintendents attempt to propagate the flathead catfish, Pilodictius olivaris, but such attempts are successful only occasionally.

Brood Fish

Originally the brood stock was obtained from our lakes and streams, but now most of our brood stock is reared in our hatcheries from the select young that have been produced in the hatcheries. At most of our twelve hatcheries a few ponds are used for experiments with farm-pond stocking, and the catfish are obtained as a by-product from these experiments.

As channel catfish are subject to several types of parasites, such as Ichthyophthirius, leeches, Argulus, and flukes (Ancyrocephalus), the brood stock is split up and held in several holding ponds to prevent the entire brood stock from being destroyed by an epidemic.

While being held, the brood fish are fed fish chopped into 1-inch cubes. These food fish are obtained from the Gulf Coast and consist mainly of whiting. Some superintendents supplement this diet with chopped beef heart.

At one hatchery it was found that in order to insure a spawn from the brood fish, they must be held in a raceway of swift flowing water several months before being paired. The exercise of swimming apparently stimulates the development of eggs.

The Hatching Pond

One of the hatchery ponds is arbitrarily chosen as the future catfish hatching pond, and pens are then built.

Figures 1 and 2 show pens constructed from wood. As the maintenance of the wooden pens required a great amount of labor, other types of material were tried. The heavy cyclone fence wire shown in figure 3 has proved the most satisfactory. One item in the construction of the pens should be noted: whether lumber or wire is used, the walls of the pens should extend down into the pond bottom at least

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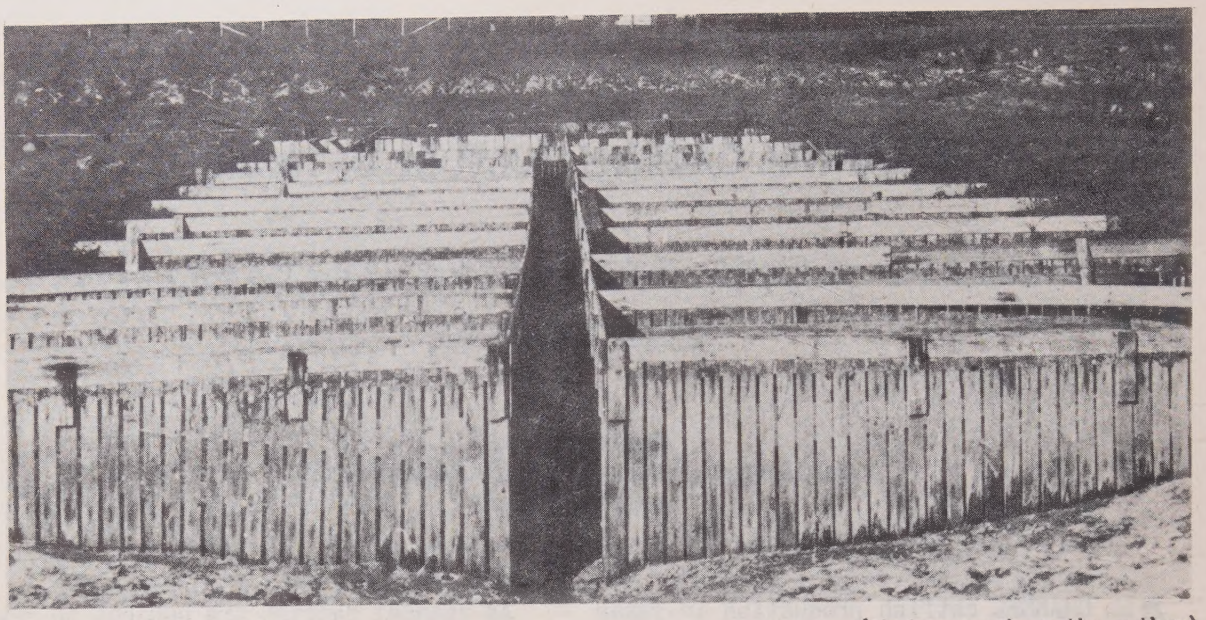
See also:

Canfield, H. L.
1947. Artificial propagation of those channel cats. Prog. Fish-Cult. 9 (1): 27-30.

Lens, Gerhard
1947. Propagation of catfish. Prog. Fish-Cult. 9 (4): 231-231-233. (Reprint from Outdoor Nebraska 25 (1): 4-6. 1947)

Morris, A. G.
1939. Propagation of channel catfish. Prog. Fish-Cult. 44: 23-27.



(Photos courtesy the author)

FIGURE 1.--Wooden hatching pens.

a foot to prevent the catfish from digging out.

It is necessary to number the pens because records on the progress of spawning must be made from day to day.

Stocking the Pens

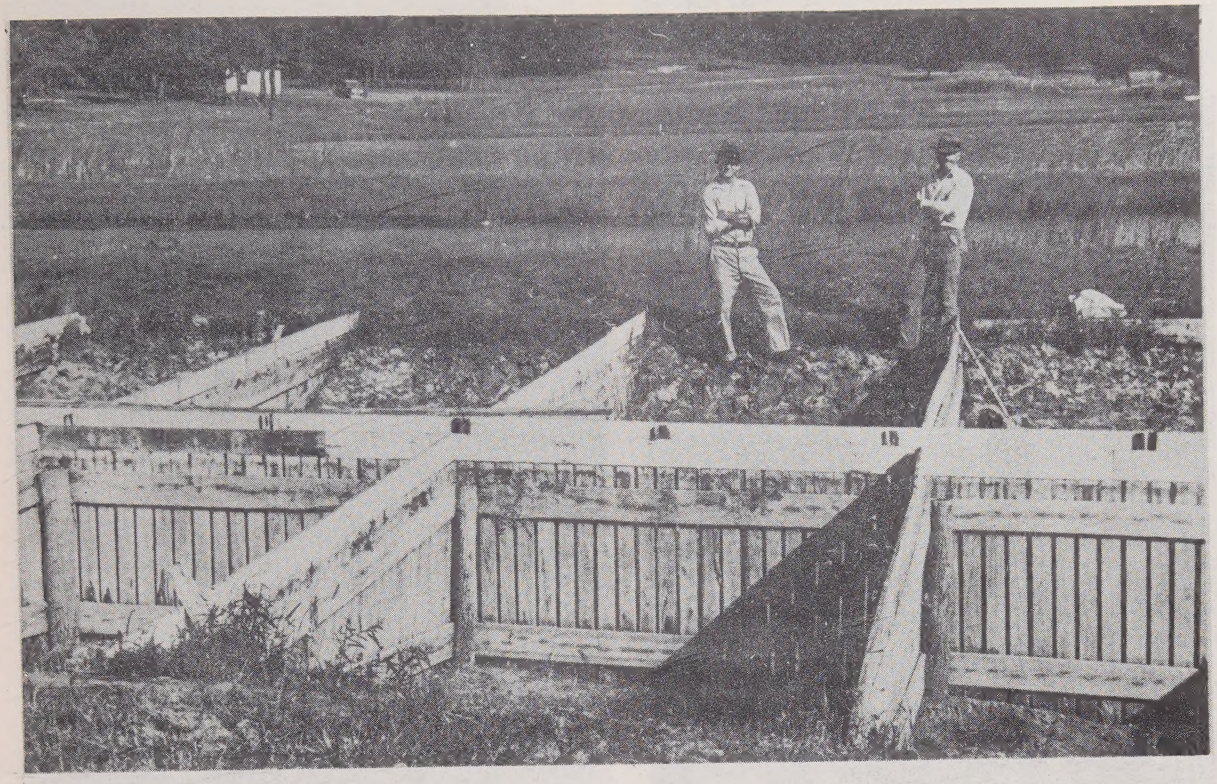
At all hatcheries, the hatching pond is filled with water about the 15th of April. The catfish brood stock is then collected and placed in holding troughs. During this operation the fish are carefully scanned for leeches and parasitic copepods. Should some be found--and they usually are in the mouth of the fish--they are removed from the fish with forceps or tweezers.

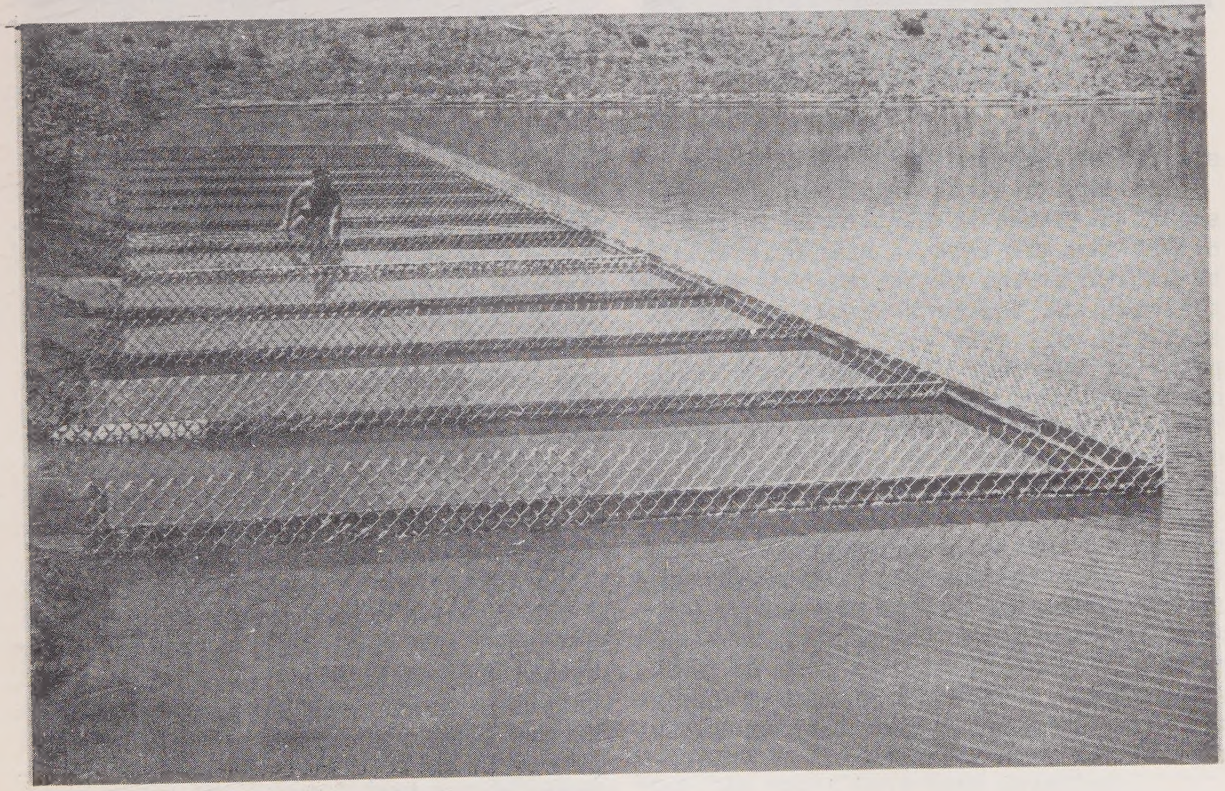
The job of sexing now begins. Figure 4 shows very clearly the difference in external characters of the urogenital opening of male and female. It may be seen that the male opening protrudes. Occasionally the sex of fish being checked does not show clearly. When this happens, a broom straw is rubbed back and forth longitudinally over the vent, as the straw will always hang on the vent of a male. The swimming catfish in figure 5 are the same fish seen in figure 4. It will be noted that the male has a much broader head. Practically all our hatcherymen are able to sex their catfish correctly.

After the males and females have been separated, the fish are paired off. At this stage a most important matter must not be overlooked. In the Texas system of catfish cultivation, the male is used to tend his eggs and see that they are properly fanned. After spawning, the female will try to get to the eggs and eat them. Consequently, the male must be a larger fish, able to fight off the female. If the male is paired with a larger female, invariably the male will be killed and the spawn eaten. Therefore, the male must be paired with a smaller female in each of the pens. Male catfish may be used more than once; some of the males in the hatcheries have successfully hatched three spawns.

Spawning Receptacles

Originally 10-gallon milk cans (see figure 6) were used for spawning receptacles. Millions of catfish were hatched successfully in these milk cans, but crock jars (see figure 7) were substituted for the cans because they rusted very badly. These jars are made to specifications: height, 22 inches; diameter, 9½ inches through the body; diameter of the mouth opening, 8 inches. Holes for handles





FIGURES 2 and 3.--Hatching pens made of wood; hatching pens made of heavy cyclone fence wire.

FIGURE 4.--Male (left) and female catfish.

FIGURE 5.--Same male (bottom) and female catfish.

are placed near the jar top, as shown.

The jars or cans, whichever are used, should be placed in the pens as in figure 6. If cans are used, a nail hole should be punched at the top of the body part of the cans and the cans should be set so that the nail hole will be the highest point of the can. When jars are used, one of the hand holes should be placed in the same position. These holes are necessary in order to effect the release of all trapped air, as it has been found that trapped air will cause the spawn to spoil. Holes are located near the top of the receptacles to prevent the fry from running out of the can or jar when the container is removed from the water. The holes in the jars or cans should be placed 8 to 10 inches under the water surface, and the bottoms should be about an inch lower.

The Hatching Process

Careful records should be kept on the progress of each pen, and each pen should be examined at least once a day. If the pond water is clear, as in figure 6, it will be possible to see what the brood fish are doing. If the water is murky, the jars must be run by feeling inside to determine whether the males are inside. As a nesting male can be vicious and will bite a hand thrust into a jar, a piece of rubber hose or an old glove is usually stuck into the jar first. If the catfish is in the jar, he will either bite the hose or glove and be pulled out or he will leave the jar of his own accord. It is safe then to examine the bottom of the jar with a bare hand. Should eggs be found, the female is netted out of the pen and placed over the pen wall into the pond, and a note is made that the pen has eggs. The pens with eggs need not be run until the fifth day after the spawns are laid. After that, the jars should be examined daily (in the same way just outlined) until fry are felt in the jar. Figures 3 and 8 show the

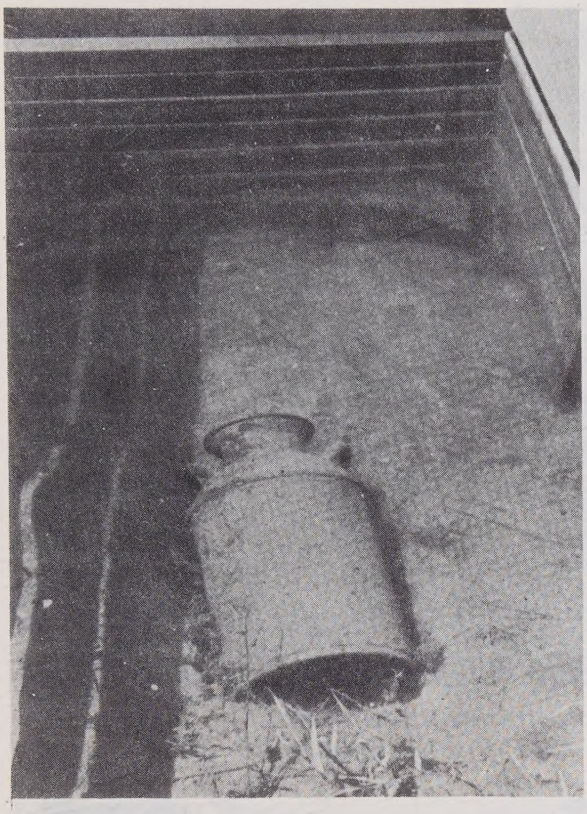


FIGURE 6.--Milk can originally used for spawning receptacle.

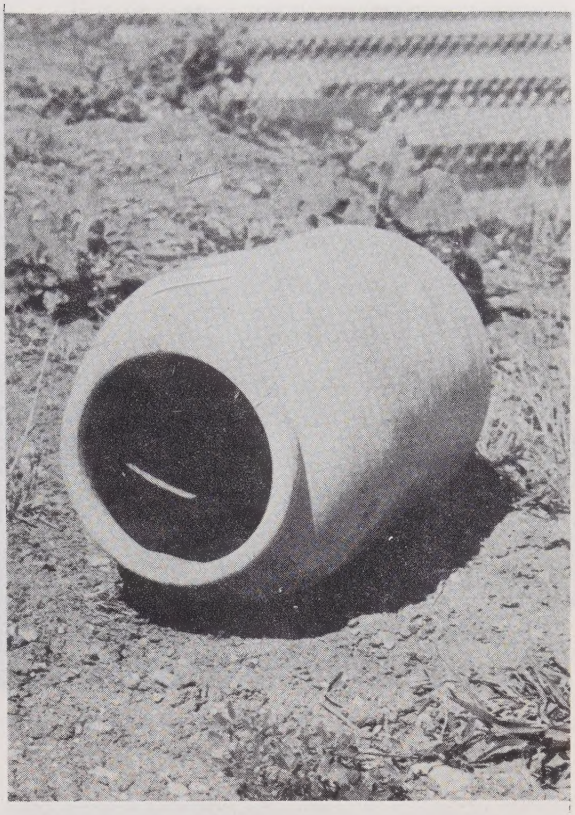


FIGURE 7.--Crock jar substituted for spawning receptacle.

jars being run.

When the fry are found, the jar is lifted out (figure 9), carried to the holding trough, and laid down in it with the mouth of the jar facing the incoming water. Some hatcheries build screen boxes (figure 10) to set the jars in; other hatcheries do not use the boxes. The purpose of the boxes is to keep the fry confined and make it possible to remove them from the trough with less chance of injury when they are ready to go to the rearing ponds.

Figure 11 shows some newly hatched fry. As soon as they absorb their yolk sacs, the fry are placed in a rearing pond. Ponds that are fourteen-hundredths of an acre in size are stocked with one spawn, ponds one-half acre in size are stocked with two spawns, and ponds an acre in size are stocked with three spawns.

In Texas the first spawns are obtained by the 15th of April. Spawning continues until the first part of August. The eggs hatch in 5 to 10 days.

Feeding the Young

After the young fry are placed in rearing ponds, artificial feeding is begun. The fry are fed ground meat scraps or tankage until they are delivered from the hatchery.

The young should be fed sparingly at first and, if possible, in about the same spot. At the start, about a 1-gallon bucketful of meat scraps is used for an acre of water. Within a week or two, the young catfish will "top" or surface when feed is cast on the water. After they begin topping, it is easier to judge how much feed to give them. They should be given all the feed they will clean up.

Should the fish stop topping for several days, trouble--such as an outbreak of ichthyophthirius--may be brewing. An outbreak of a disease usually indicates that the young have been underfed.

Two spawns of catfish in a half-acre pond require about 3,500 pounds of meat scrap over a period of three and one-half

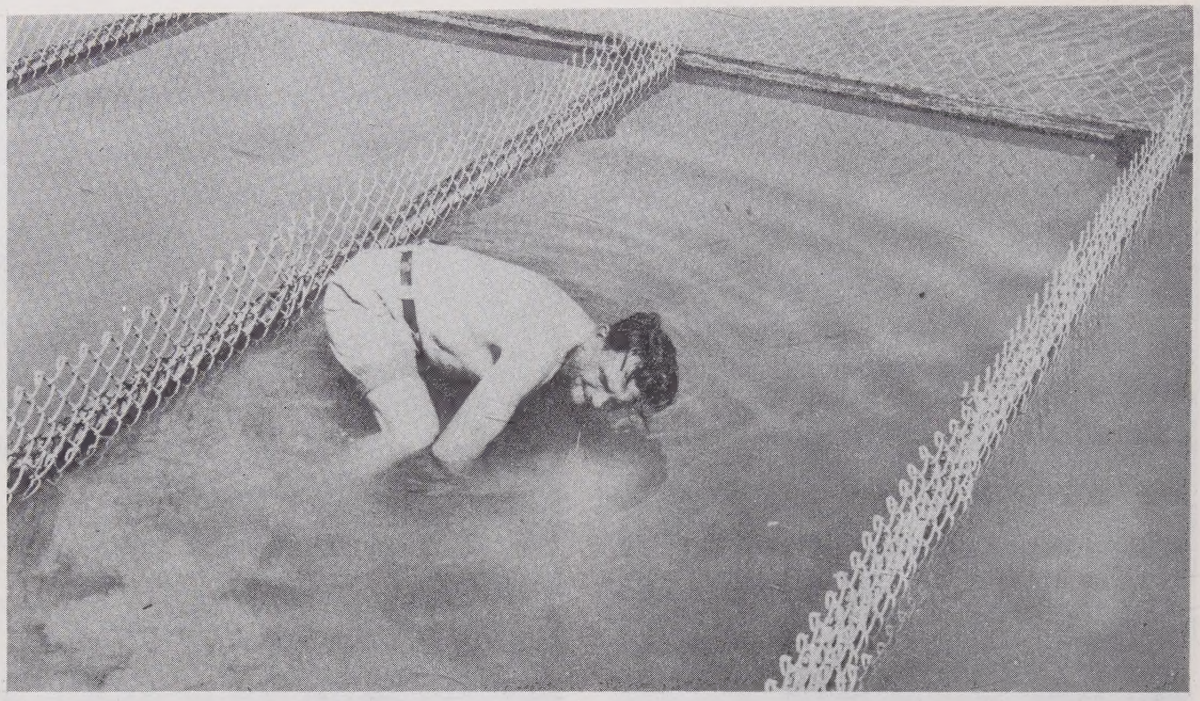


FIGURE 8.--Jar in pen being examined for spawn.

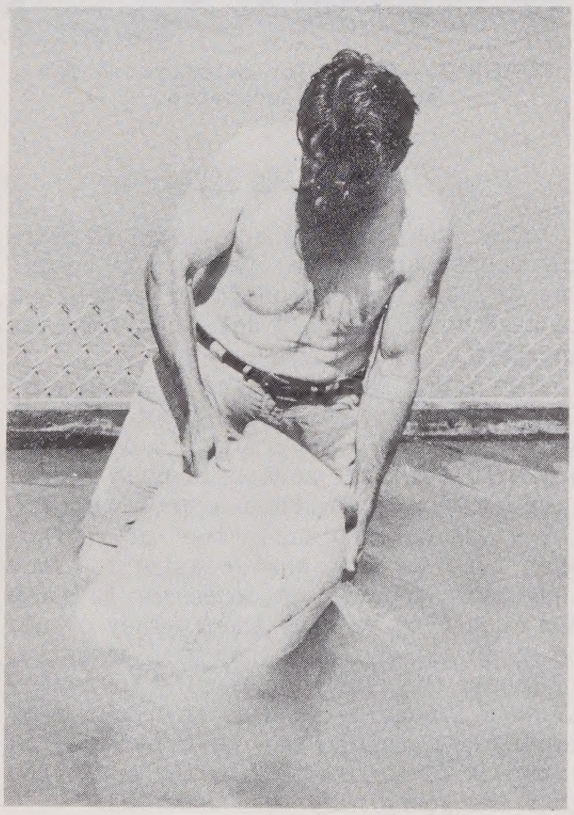


FIGURE 9.--Jar with fry being removed from pen.

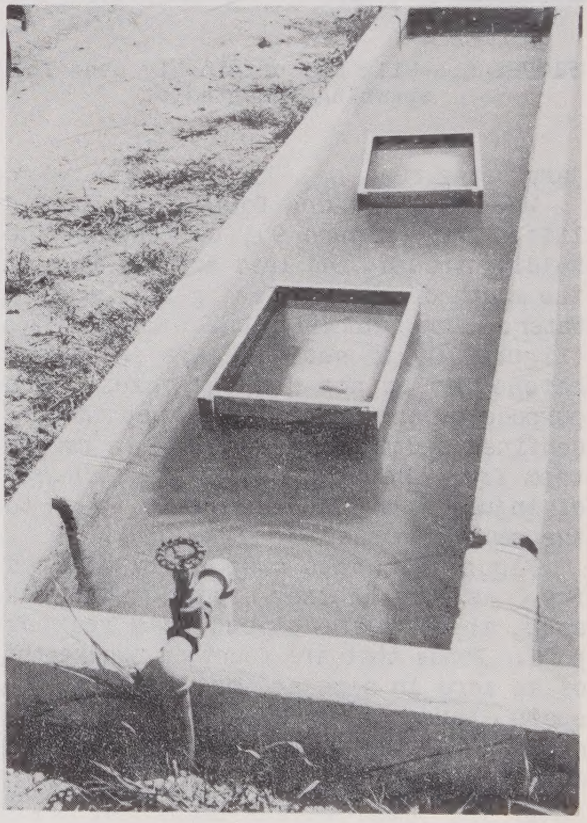


FIGURE 10.--Jars set in screen boxes, open ends toward incoming water.

months. This breaks down to roughly 34 pounds of feed per day, but considerably less than that is fed at the start, and more and more feed is given as the young fish grow.

Multiple Pond Use

The State hatcheries use their hatchery ponds for at least two fish crops per year, owing to the fact that catfish are hatched later than black bass. All bass hatching ponds are drained about the first of May; as the later spawns of catfish occur, the catfish are stocked back into the bass hatching ponds. Other ponds at the hatchery are first stocked with bass fry, which are drained early (as No. 1 fingerlings) to make room for the catfish fry.

Meat scrap or tankage usually has a large percentage of ground bone, which is not eaten by the catfish. As a result, catfish ponds will usually be extremely fertile the next year and therefore excellent for rearing bass.

FIGURE 11.--Newly hatched fry.

CHANNEL CATFISH PRODUCTION OF FOUR TEXAS HATCHERIES, 1949

Hatchery and pond	Pond size	Spawns stocked	Date stocked	Food consumed	Date taken	Number taken	Average weight per 100 taken
	(acres)			(pounds)			(pounds)
Ingram							
No. 4	0.33	2	6/3	2,700	9/22	19,400	1.5
No. 6	0.59	2	5/14	2,508	8/31	3,500	2.0
No. 12	0.38	2	5/13	3,540	9/13	15,840	1.5
No. 23	0.45	2	5/30	3,258	10/13	29,800	3.0
No. 28	0.48	2	5/20	3,678	10/4	17,500	2.0
San Marcos							
No. 36	0.28	1	5/10	(1/)	11/14	21,300	2.18
No. 41	0.14	1	5/18	(1/)	11/16	11,241	3.6
No. 42	0.15	1	5/18	(1/)	11/7	12,795	3.5
No. 43	0.15	1	5/28	(1/)	9/26	13,675	3.5
No. 44	0.15	1	6/6	(1/)	11/17	10,899	4.6
No. 45	0.13	1	5/16	(1/)	10/16	23,095	2.5
No. 46	0.13	1	5/10	(1/)	9/12	6,627	6.24
San Angelo							
No. 13	0.80	2	5/30	1,400	9/2	5,064	1.0
No. 15	0.75	1	6/10	900	7/26	3,286	1.12
No. 16	0.34	1	4/26	1,600	9/3	2,532	1.5
Huntsville							
No. 6	0.48	2	5/21	(1/)	10/6	20,200	1.24
No. 16	0.30	1	6/1	(1/)	10/25	10,250	1.5
No. 19	0.62	3	5/27	(1/)	12/19	28,375	3.24
No. 35	1.76	4	6/10	(1/)	12/2	33,400	3

1/ Quantities not recorded; meat scraps fed daily.

Texas Hatchery Production and Stocking

By using the foregoing method of hatching channel catfish, the hatcheries that attempted to produce these fish were able to rear and distribute 973,900 channel catfish for the fiscal year ending September 1, 1949--a production which amply takes care of all the stocking requirements.

The table is included to show the 1949 channel catfish production data from four hatcheries.

In stocking farm ponds, channel catfish are used either by themselves or in combination with bass and redear sunfish. When used with bass and redear sunfish, 50 channel catfish are stocked with 100 black bass and 100 redear sunfish per acre. When stocked alone, 75 channel catfish per acre are used.

The writer has received verified reports stating that several pond owners, 9 months after stocking their unfertilized ponds at the rate of 100 fingerling catfish per acre, were able to catch channel catfish that measured approximately 15.75 inches long. A better growth rate has been obtained, however, by stocking fewer fish.

Ponds smaller than one quarter of an acre usually are stocked with catfish alone because it is felt that catfish will give the pond owner a maximum yield of food fish.

We also like channel catfish for stocking purposes because these fish seldom reproduce successfully in ponds and, as a result, fail to overpopulate the ponds as do many other fishes.

DEVELOPMENT OF A NON-MIGRATORY STRAIN OF RAINBOW TROUT

There are undoubtedly hereditary differences in the several strains of rainbow trout that are now being produced and that have been developed through selective breeding in the United States. Unfortunately, because so few records have been maintained for the various strains produced at the hatcheries, there are few, if any, stocks that really have a pedigree or warranty.

With an eye to the attainments made in animal husbandry, fish-culturists are now laying plans for the development of a non-migratory variety of rainbow trout. For this purpose, 50,000 eggs from the brood stock at the U. S. Fish-Cultural Station at Manchester, Iowa, are to be distributed among the States of Maryland, Michigan, New York, North Carolina, and Wisconsin. The program will probably call for comprehensive checks to determine the actual characteristics of the Manchester strain of rainbow trout, marking of all the trout, plantings in at least some areas that are largely closed to angling, plantings in streams in which the trout will be able to migrate freely, frequent checks by such devices as the electric shocker, and creel censuses in areas where angling is permitted.

AN IMPRESSION METHOD FOR PREPARING FISH SCALES FOR AGE AND GROWTH ANALYSIS

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SINCE CONCENTRIC rings on fish scales were first recognized as being indicative of growth, scale study has become an increasingly important part of fishery investigation. Before scales from most species of fish are studied, they are mounted for observation under a microscope or some other magnifying apparatus.

This paper deals with procedures in preparing fish scales for analysis and describes in detail the method used for a number of years by the North Atlantic Fishery Investigations of the Fish and Wildlife Service. The incentive to write the paper was provided by numerous inquiries received through the mail and by the interest evinced by many fishery biologists visiting the headquarters at Woods Hole, Massachusetts.

REVIEW OF REPRESENTATIVE METHODS

Mounting without Medium

Temporary Mounts

Scales are arranged on a transparent slide; where illumination involves heat, often a cover slip is added to prevent curling of the scales. This is the simplest process of preparing fish scales for examination. This method has been adequate for studying scales of haddock up to 3 or 4 years of age and has been satisfactory for scale studies of many other species.

Mounting with Medium

Temporary Mounts

Scales may be immersed in a clear liquid medium (water, glycerin, etc.) before examination. The liquid aids in keeping scales flat and permits them to be moved around deftly with a dissecting needle--without "snapping" out of the field, as frequently occurs in dry mounts.

Permanent Mounts

Scales may be placed within a transparent liquid matrix (balsam, Karo, waterglass and glycerin, or a plastic such as Clarite) that subsequently hardens into a permanent mount. Before immersion, selected scales (those having no regenerated centers) should be carefully cleaned and sometimes stained to bring out certain structural elements. Clarite, a hydrocarbon resin, in a mixture of 60 percent Clarite to 40 percent toluene (by weight) remains clear indefinitely, unlike the other media that tend to whiten with age and thus impair legibility. This is a comparatively slow and tedious process that is still widely used whenever it is

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This material appeared in Physis; Revista de la Asociacion Argentina de Ciencias Naturales, in 1950.

See also:

Lewis, W. M., and Carlander, K. D. 1949. A simple method of mounting scales. Prog. Fish-Cult. 11 (4): 263.

desirable to have the whole scale available for study of internal structures, or where scales are too large or soft to give good results by impression.

IMPRESSION METHOD

In the foregoing methods, mounting consisted of preparing the actual scale for analysis. It has been found that scales from older fish of many species are extremely difficult, and in some cases impossible, to read when mounted by these techniques. This is due primarily to the thickening of the scale with age and a corresponding increase in light refraction so that growth of early years often is entirely obscured. This problem was overcome to a large extent when Lea (Lea and Went 1936) in 1918 proved in regard to herring scales that:

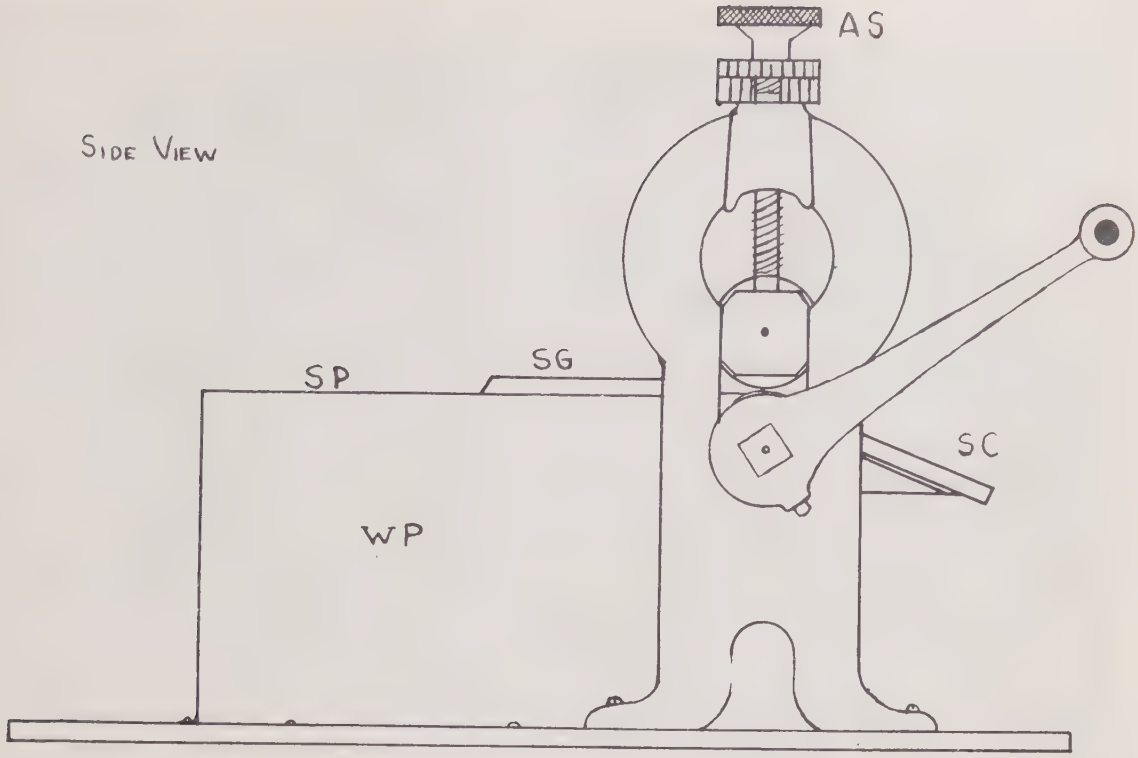
> "... all details which are subjected to observation when the scales are used for the purpose of age determination and growth calculations, arise from the play of light on the delicately moulded relief forming the outer surface of the scales. The structural elements below the surface and on the inner surface of the scales are of no direct interest in the practice of scale analysis."

Lea determined this by making casts of the sculptured surface in thin celloidin films. His comparison of these casts with the original scale revealed that the imprints were as good as the originals in analysis for age and growth--and sometimes better. The celloidin films were delicate, however, and necessitated immediate examination or copying by photography. Recognizing the need for permanency and the value of making copies of scale details for other interested investigators, Lea and Went developed a method that entailed pressing the sculptured surface of the scale against the softened surface of a celluloid plate (solvent consisted of 3 parts of pure redistilled acetone, 1 part of amyl acetate), which gave a negative relief of the scale surface, as in the celloidin film. The celluloid impressions were then filled with a gelatine sol (880 cubic centimeters of water, 120 grams of pulverized gelatine, 20 grams of glycerin warmed gently to about 50° C.), which upon hardening resulted in a fairly durable film bearing positive copies. It was possible to make as many of these "positives" as were desired. Lea and Went further determined that the technique was satisfactory not only for herring but also for many other species, including the Gadidae group, mackerel, salmon, and rosefish. Impressions were made either by means of a 20-minute process in a hydraulic press, or by use of carpenter's clamps, requiring approximately 2½ hours. A number of copies could, of course, be made in one operation.

Nesbit (1934) used a similar procedure to study scales of the squeteague (Cynoscion regalis). Nesbit softened his celluloid plates either by moistening them slightly with alcohol or by exposing them to acetone vapors for several minutes. His impressions were made with a seal press of the type used by notaries, the dies being smooth and highly polished. Best results were obtained with clean, dry scales.

Though Nesbit could readily obtain positive replicas "by pressing the dry scales into heavy lead foil and allowing a few drops of a viscous solution of celluloid in acetone to dry in the depression," he concluded that they were no more desirable for ordinary purposes than mirror-image impressions and were less convenient to store and examine.

After considering and trying existing methods, and finding all of them inadequate in some aspects, the Fish and Wildlife Service's North Atlantic Fishery Investigations developed a modified impression procedure for the preparation of the extensive collection of haddock (Melanogrammus aeglefinus) scales for examination. In this procedure, cellulose nitrate was first used as the impression medium. Two innovations improved the original process: use of a jeweler's type of roll press (figure 1), and softening of the plastic slide by heating on a warming platform connected directly to the press. The platform is made of



AS - Adjusting screws
WP - Warming platform
SP - Surface of WP
SC - Slide catching tray
SG - Slide guide
G - Roller gears
RS - Roller surface (upper)
LS - Light switch

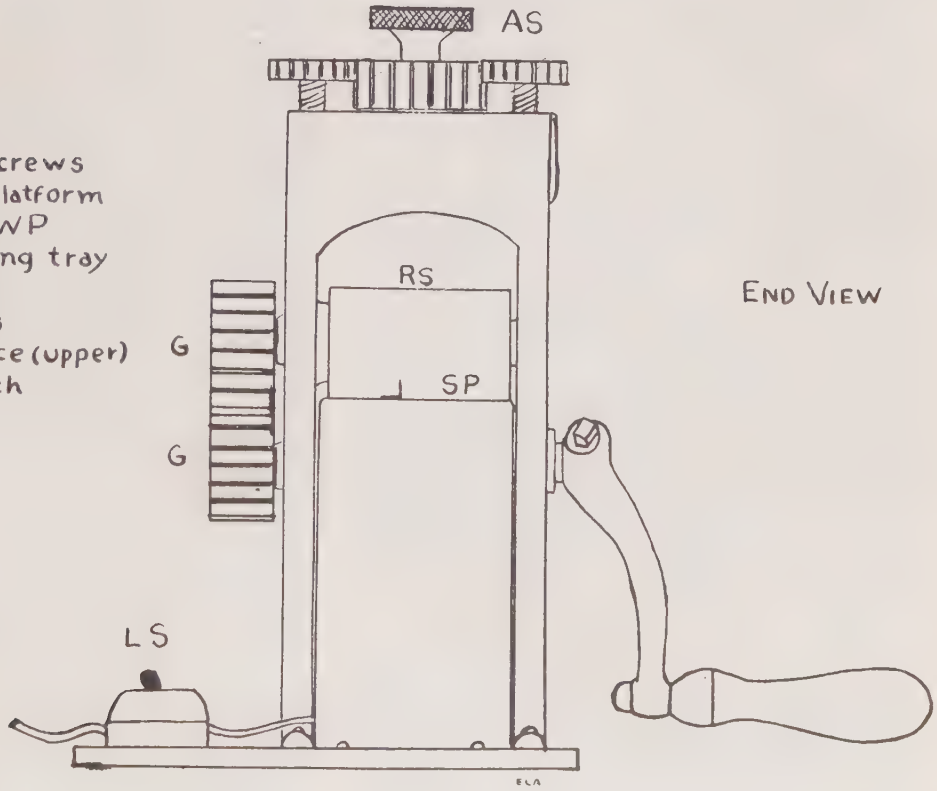


FIGURE 1.--The roll press.

sheet copper to house the heat source, a common 20-watt light bulb, and is attached to the baseboard of the press, the end of the warming surface extending nearly to the rollers. Slides may be moved along this surface and into the rollers without disturbing the alignment of the scales. Softening of the cellulose nitrate by warming eliminates treatment by volatile and highly inflammable chemicals--a decided advantage. The rollers of the press are readily adjustable for different thicknesses of slides, so that it is possible to make impressions of the scales of various species.

When the cellulose-nitrate impressions were stored for an appreciable period, difficulties were experienced. Chemical reactions, for instance, caused bad discoloration and cracking. Handling of such slides often resulted in their disintegration. Furthermore, because the plastic was highly combustible, it was necessary to store the slides in a basic aqueous solution. These difficulties were overcome by the adoption of another plastic material, cellulose acetate, as an impression medium. Relatively fireproof, unbreakable, and very durable, this material has proved most satisfactory (figure 2).

Sheets of the plastic, 0.02 inch in thickness, are cut into slides with a photographic print cutter. Dimensions of slides depend on the size of the scale and the method of storage. For haddock scales, 2½ by ½ inch was chosen as the most suitable size. Each slide is prepared for mounting by inscribing abbreviated pertinent data, i.e., the serial number, area where fish was caught, and length of fish, on the right-hand end. Labeling is done with a special black opaque ink that is indelible, waterproof, and has the property of etching the plastic surface--because of its acetone content--and thus cannot be rubbed off. The ink requires several hours to dry.

Clean scales are a prerequisite for clear, legible impressions. In haddock work, this condition is very easily met by scraping body slime and foreign matter from the surface of the fish before taking scales. The scales (15 to 30) are then placed between sheets of thin blotting paper in a small coin envelope.

For the actual mounting or impressing routine, six or seven scales which do not have regenerated centers are selected from each scale envelope. These scales are placed, sculptured surface downward, on the slide bearing the same serial number. The edges of most scales tend to curl in the direction opposite the sculptured surface when correctly placed; in others, the sculptured surface can be determined by gentle stroking with a dull needle. A microscope or dissecting-scope is unnecessary for these operations, although a hand lens may be useful for examining very small scales. For uniformity and easier reading, the anterior radii of the scales, usually the broader ends, are pointed toward the top of the slides. The slide is then placed on the warming platform, labeled end toward the rollers, for approximately 10 seconds. The now slightly softened slide is run through the rollers of the press. The scales usually drop off in the process, but some adhere to the rollers. Constant care should be exercised, therefore, to keep rollers free of scales so that contamination of succeeding mounts will not occur. Impressions are frequently checked for legibility and proper roller adjustment. Although most of our work has been done with haddock scales, we have found it possible to produce satisfactory impressions from the scales of almost any other species of fish. The proper combination of heat, pressure, and thickness of celluloid (cellulose acetate) is generally easy to determine. Sometimes, as with scales which are thick in the center, an extra celluloid strip on top of the scales results in a better impression. Passage of the slides through the rollers often causes them to curve upwards at the ends. This undesirable effect is corrected by immediately placing each newly made impression, curved surface downward, in a receiving niche cut into a small block of wood and putting a lead weight on top of the mounts.

When a group of 20 slides has been completed, the slides are bundled together and passed on to the analyst. The envelope with remaining scales is stored as insurance against possible loss of impressions.

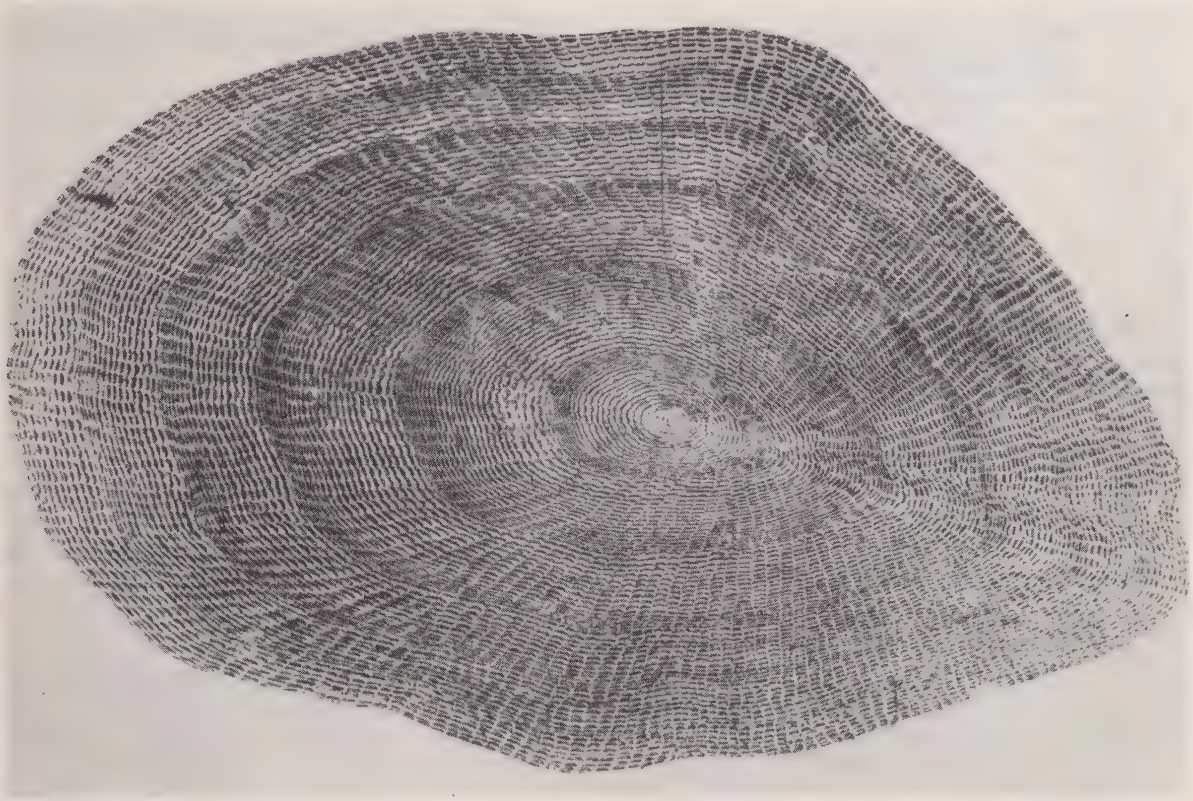


FIGURE 2.--Photograph of an impression made from the scale of a 6-year-old haddock.

To facilitate examination of the impression mounts under a microscope, a holder should be constructed as shown in figure 3. The size of holder would, of course, depend on the size of slide used. The holder should be made of a heavy metal substance, such as brass, with hold-down clamps of any springy metal. If a mechanical stage is available, the plastic mounts can be placed over a glass slide and held down by similar clamps attached to the stage.

Advantages of Impression Method

The advantages of the method for impressing haddock scales, as described, may be summarized as follows:

1. Increased legibility. This is especially true for reading scales of older fish.

2. Less storage space required. Four hundred slides can be stored in the common slide box that holds only 25 glass slides. In our situation, with a collection of some 80,000 haddock scale slides, storage of the glass type would present difficulties.

3. Relative speed of the process. An average of 200 mounts a day can be turned out by a competent technician. This does not include cutting and labeling of the slides.

4. Durability and moderate cost of mounting medium and apparatus. The plastic is practically unbreakable, retains legible impressions indefinitely, and is substantially cheaper than glass--800 2½- by ½-inch slides can be cut from a 20- by 50-inch sheet costing about $2.15. The roll press and platform are also durable and relatively inexpensive--the cost

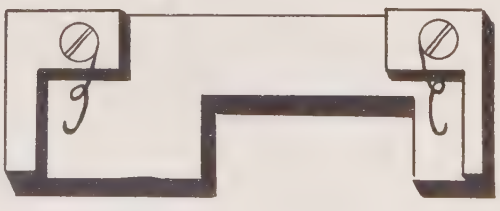


FIGURE 3.--Holder for plastic slides.

of the press is approximately $30; that of the platform is negligible.

5. Uniformity of impressions. The roll press exerts constant pressure with little need for adjustment.

ACKNOWLEDGMENTS

The writer wishes to acknowledge the work of W. C. Herrington, John R. Webster, Howard A. Schuck, and others of the Fish and Wildlife Service whose contributions from 1931 to the present time resulted in many improvements in the technique of scale mounting. The writer is also indebted to Mr. Schuck and Drs. Lionel A. Walford and Wm. F. Royce for helpful suggestions in the preparation of this manuscript.

LITERATURE CITED

Lea, Einar, and Went, A. E.
1936. Plastic copies of microscopical reliefs, especially fish scales. Hvalradets Skrifter. Det Norske Videnskaps-Akademi, I Oslo. Nr. 13. Oslo.

Nesbit, Robert A.
1934. A convenient method of preparing celluloid impressions of fish scales. Jour. du Conseil. 11 (3): 373-376. Copenhagen.

Economists generally recognize that the growing human population will eventually be limited by the world's food production, but too few fishermen appreciate the fact that trout and other fresh-water fish populations are inevitably affected by the decrease in the hatches of aquatic insects along our streams. With the advance of civilization we are demanding more sport fish--and destroying their natural food. The eggs that Mayflies, caddis, and stone flies lay on wet, glistening black-top highways usually represent a total loss. Millions of eggs are lost each summer evening when insects accumulate on windshields and headlights. In addition to these almost unavoidable losses, many fishermen are heedlessly destroying natural food resources. For example, the larva of the crane fly, increasing in popularity as a bait, is frequently collected by removing from the stream a mass of aquatic plant material that also contains thousands of scuds, Mayfly nymphs, caddis cases, and other forms of aquatic life. A step in the right direction has been taken by the States that now prohibit the removal of any natural food from a trout stream.

DIET EXPERIMENTS WITH TROUT

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1. A SYNTHETIC FORMULA FOR DIETARY STUDIES

THE WRITER wishes to describe a synthetic diet suitable for determining various dietary requirements of trout. It is emphasized at the outset that this is not proposed as a practical hatchery diet but only for investigations into the vitamin, mineral, and other food requirements of fish.

Lack of a suitable synthetic diet, on which normal growth could be maintained for extended periods, has hampered the study of trout food requirements. One of the major difficulties has been to obtain a product which would not disintegrate in water. Any feed which breaks up quickly will allow too much leaching of the water-soluble components, thereby preventing any accurate estimation of the quantities actually ingested by the fish. Some investigators have resorted to such a device as inclosing the feed in gelatin capsules, which are then inserted into the stomachs of the fish. This method is impossible with small fingerlings and is extremely time-consuming with larger fish. It can also introduce an error through regurgitation of the capsules by the trout.

The well-known Cortland break-down diet has been used in many anemia studies (Phillips et al. 1947). It is a synthetic diet containing 5 percent dried brewers' yeast. In the writer's experience, the mixture is not eaten readily by trout and it disintegrates in water. Theoretically, with the yeast left out, the Cortland diet might serve as a vehicle for individual pure vitamins in vitamin-requirement studies. It is not possible, however, to obtain normal growth for even short periods with this mixture.

In devising a synthetic diet, it seemed desirable to conform as closely as possible to the proportions of the various food categories found either in the food of wild trout or in a food known to give good growth in hatchery experience. The writer therefore built his formula around the data given by Embody and Gordon on the natural food of trout (1924) and the analysis of beef liver given by Atwater and Bryant (1906). See table 1.

The ingredients used by the writer for the synthetic diet consisted of:

	(parts)
Commercial casein (Borden B 3 F) -----	55
Gelatin ----------	15
Crisco (or lard) -----	9
Potato starch (cooked) ----------	8
Cellu flour ----------	9
Minerals ----------	4

With the 100 parts of dry ingredients listed, 300 parts of water are used. When cod-liver oil is to be included, 2 parts of fat are replaced by the oil.

The casein must be finely ground, the quality here indicated being satisfactory. Potato starch has better binding qualities than corn starch. Numerous other products, such as tapioca, "Mucilose" (psyllium seed), and vegetable gums, have been tried for their binding effect, but none

TABLE 1.--Composition of trout feeds

	Natural feed	Beef liver	Synthetic diet
Protein	48.7	72.3	70
Fat	15.5	16.0	9
Carbohydrates			
N-free extract	17.9	6.0	8
Crude fiber	8.0	-	9
Ash	9.9	5.7	4
Totals	100.0	100.0	100
Moisture		253	300

were satisfactory. Cellu flour is used to supply indigestible bulk. Other materials of this nature would serve the purpose but must be finely ground.

The mineral supplement consists of U. S. P. XII Salt Mixture No. 2, to which the following trace elements have been added per 100 grams:

Aluminum chloride --	18 mg.
Zinc sulfate -------	357 mg.
Copper gluconate ---	511 mg.
Manganous sulfate --	80 mg.
Potassium iodide ---	17 mg.
Cobalt chloride ----	105 mg.

For a complete diet, the following vitamins have been used:

Thiamine ----------	6 mg.
Riboflavin ---------	20 mg.
Pyridoxine ---------	4 mg.
Choline ----------	800 mg.
Para-aminobenzoic acid ----------	40 mg.
Niacin ----------	80 mg.
Calcium pantothenate ----------	28 mg.
Inositol ----------	400 mg.
Biotin ----------	0.6 mg.
Folic acid ---------	1.5 mg.
B12 ----------	9 mcg.
Alpha tocopherol ---	40 mg.
K ----------	4 mg.
C ----------	200 mg.
A and D (cod-liver oil, to replace same amount of fat in original formula) ---------	2 ml.

The quantities given are for 100 grams of the dry ingredients or 400 grams of the wet, ready-to-feed diet. These quantities are probably, in most cases, greatly in excess of the actual needs of trout, and some of them are, no doubt, not necessary at all.

It should be mentioned that commercial casein contains small amounts of some of the B vitamins: if the diet is to be used in vitamin studies, it would be better to use "vitamin-free" or "vitamin-test" casein. We have been unable, however, to obtain any which trout would eat. The vitamin-test casein we have tried has had a strong alcoholic odor which is apparently objectionable to trout. They will eat very little of it and will gain very little weight. Thorough and repeated washing of such casein with distilled water prior to use in the diet will make the casein palatable for trout, but this procedure has proved difficult and time-consuming because the casein does not wet readily.

Preparation of Diet

About a third of the water (cold) is poured over the gelatin, and this is allowed to soak. The starch is then put in the rest of the water in a double boiler and cooked until dissolved. As the starch starts to turn transparent, it must be stirred; otherwise, it forms a tough mass which can be dissolved only with the greatest difficulty. The wet gelatin is then added to the hot, cooked starch and is stirred in thoroughly while the cooking is continued for a brief period. The gelatin should not actually boil. The boiler is then removed from the stove, and the fat and cod-liver oil are added. After the fat has melted and been stirred in, the remaining ingredients are added in one mass. There is no further cooking. It is desirable to hasten the cooling process by placing the container in cold water while mixing in the final ingredients. If the cooling has been adequate, the result is a thick, firm product which will not settle out in layers.

When kept in a refrigerator, the mixture remains solid indefinitely. For feeding it is chopped into small pieces. These pieces are not sticky but will hold their shape and not disintegrate in cold water, though, of course, good feeding practice demands feeding only as much

as the fish will clean up within a short time.

Experimental Test of Complete Synthetic Diet

On December 13, two lots of rainbow fingerlings were started on an experiment to compare the synthetic diet with beef liver. The fish used were small, the weight per fish averaging 5.172 grams in Lot No. 1 and 4.383 grams in Lot No. 2. There were 175 fish in each lot.

Throughout the 25 weeks of the experiment, Lot No. 1 received a diet of edible beef liver and Lot No. 2 received the complete synthetic diet.

Both lots were weighed once a week, and the amount of feed (all given in a single daily feeding) was adjusted according to the Deuel and Tunison tables (1944).

During the course of the experiment, the number of fish in both lots had to be reduced twice because of overcrowding. The reductions were made by removing the smallest and the largest fish.

At the beginning of the 14th week, vitamin-test casein was substituted for the commercial casein in the diet of Lot No. 2. This greatly depressed the growth rate in the lot for one week, after which a return to commercial casein brought the growth back to normal.

Haskell (1948) has pointed out the advantage of using increments in the cube root of the average individual weight of fish as a basis for recording growth. When such increments are plotted against time on ordinary graph paper, the result is a straight line. Any deflection from a straight line is much easier to detect than a deflection from a curve such as would result from any other method of recording weight increment. A table of the weekly increases in the cube root of the weight of the fish lends itself very readily to statistical analysis, for, if conditions do not change and the diet is complete in all essentials, the weekly increases would be uniform throughout the period of observation.

In the present paper only a summary of the growth record will be given. In this summary the figures for the one bad week, caused by using the vitamin-test casein, have been omitted. The average weekly increase in the cube root of the weight in grams (multiplied by 1,000 to eliminate decimals) was 44.3 for the liver-fed and 43.8 for the synthetic-diet-fed trout. According to the chi-square test, there is no significant difference in the two figures. It is interesting to point out that during the last 6 weeks the synthetic-diet-fed group outgrew the liver-fed.

At the end of the 25th week, blood-cell counts were made from five fish in each lot. These counts averaged 1,327,000 cells per cubic millimeter for the liver-fed lot and 1,442,000 for the synthetic-diet-fed. According to the chi-square test, the advantage in favor of the latter group has some significance.

A comparison of the mortality in the two lots is necessary to complete the picture. During the first 15 weeks the mortality in the two lots was identical: a total of four fish in each lot. Thereafter a bacterial infection appeared in a number of lots which were under experiment at this time, causing a scattered but persistent mortality which seemed to have no connection with any of the diets. This infection spread to Lot No. 2 but not to the liver-fed group, with the result that during the final 10 weeks 12 fish died in Lot No. 2 but only 3 in Lot No. 1. At this same time, however, in another test-lot which was being fed the same diet as Lot No. 2 except that it lacked vitamin B_{12}, the mortality for the entire 25 weeks was 8 and the mortality for the last 8 weeks was 2--the identical number as in the liver-fed lot.

Summary

The synthetic diet described has, in the opinion of the writer, advantages over the diets so far used by other investigators and described in published reports. This diet is suitable for studies of vitamin and mineral requirements, as well as of other food factors, in the diets of trout.

In a 25-week test period, the growth rates of rainbow trout on the synthetic diet and on a diet of edible beef liver

did not differ significantly. The red-blood-cell count was somewhat higher in a sample of five fish from the synthetic group than in a sample of five fish from the liver-fed group. Mortality was somewhat higher in the synthetic-fed group, but this mortality was not attributable to the diet.

It would be desirable to continue fish on the synthetic diet for a much longer period, in fact, through a reproductive cycle. From the data on hand, however, it appears that the diet is suitable for a minimum of 6 months--perhaps much longer. It also remains to be established that this diet is adequate for other species of trout.

2. EFFECT OF MINERAL SUPPLEMENTS IN DIETS OF RAINBOW TROUT

THREE lots of rainbow trout fingerlings were placed on synthetic diets in which the mineral supplement was the test variable. The fish were small, averaging between 4 and 5 grams in weight. There were 175 fish in each lot.

Except for the minerals, the diets were identical with the synthetic diet described in the first section of this paper. For the mineral supplement, Lot No. 1 received U. S. P. XII Salt Mixture No. 2[1/] at the level of 4 percent of the total dry ingredients of the diet. Lot No. 2 received the same amount of Salt Mixture No. 2, to which the following minerals had been added per 100 grams of mixture:

Aluminum chloride --	18 mg.
Zinc sulfate -------	357 mg.
Copper gluconate ---	511 mg.
Manganese sulfate --	80 mg.
Potassium iodide ---	17 mg.
Cobalt chloride ----	105 mg.

Lot No. 3 received no minerals whatever in the diet.

The experiment continued for 23 weeks. Throughout this period, all lots were weighed once a week and the amount of feed was adjusted according to the Deuel and Tunison tables (1944).

During the course of the experiment it was necessary to reduce the number of fish in all three lots to avoid overcrowding. This was done by removing the smallest and the largest fish.

As in the study described in the first section of this paper, the basis for comparing the growth of the three lots was the weekly increase in the cube root of the weight (Haskell 1948). At the beginning of the 12th week, vitamin-test casein was substituted for the original commercial casein. The vitamin-test casein was not eaten readily by the fish. In an attempt to find out whether the fish would get used to the new casein, it was continued in one of the lots for several weeks. The attempt had to be abandoned, however, and the vitamin-test casein was replaced with the ordinary commercial grade. For a period of 5 weeks (the 12th through the 16th), the three lots were not comparable, even though the mineral component of their diets was not changed. It is possible, therefore, to compare only the growth rates for the first 11 and the last 7 weeks of the experiment, or 18 weeks in all.

The average weekly increases in the cube root of the weight in grams (multiplied by 1,000 to reduce decimals) for the three lots were as follows: Lot No. 1, 43.39; Lot No. 2, 46.11; Lot No. 3, 40.72. Although the growth was best in the group

1/ Salt Mixture No. 2: sodium chloride, 4.35; magnesium sulfate, 13.70; sodium biphosphate, 8.72; potassium phosphate, 23.98; calcium biphosphate, 13.58; ferric citrate, 2.97; calcium lactate, 32.70.

getting the complete mineral supplement, and poorest in the group getting no mineral supplement, the chi-square test indicates that the differences have no statistical significance.

At the end of the experiment, blood-cell counts were made from five fish in each lot. These counts averaged as follows: Lot No. 1, 1,338,000; Lot No. 2, 1,442,000; Lot No. 3, 1,415,000. According to the chi-square test, there is no significance to the differences in these averages.

A comparison of the mortality in the three lots also reveals no significant differences. For the 18 weeks on which the comparison is based, the mortalities were as follows: Lot No. 1, 18; Lot No. 2, 8; Lot No. 3, 12. No trend manifested itself in the mortalities, which, if caused by the mineral situation, should have shown an increase as the experiment continued. Such an increase did not occur. Mortalities for the last 6 weeks were as follows: Lot No. 1, 2; Lot No. 2, 4; and Lot No. 3, 1.

Summary

A 23-week diet experiment with fingerling rainbow trout, during which good growth was maintained on a synthetic diet, did not reveal the need for any mineral addition to the diet. In the hatchery in which these trout were reared, their mineral requirements could apparently be met from the solutes in the water. It is conceivable that in another water supply other results might have been obtained.

3. EFFECT OF THE LACK OF CERTAIN VITAMINS ON RAINBOW TROUT

AN EXPERIMENT was performed to determine which vitamins, of a restricted list, are essential for rainbow trout fingerlings. The basal diet was the synthetic diet described in the first section of this paper, with the complete complement of vitamins there given. These included the following (per 100 grams of dry diet, or per 400 grams of diet as fed):

Cod-liver oil	2 ml.
K	4 mg.
Thiamine	6 mg.
Riboflavin	20 mg.
Choline	800 mg.
Para-aminobenzoic acid	40 mg.
Pyridoxine	4 mg.
Niacin	80 mg.
Calcium pantothenate	28 mg.
Inositol	400 mg.
Biotin	0.6 mg.
Folic acid	1.5 mg.
B_{12}	9 mcg.
Alpha tocopherol	40 mg.
C	200 mg.

The first seven of these were included in all the diets; the remaining eight were variously omitted.

Thirteen lots of fish were used in the experiment. Each lot contained 175 fish. The fish averaged between 4 and 5 grams in weight at the start. All lots were thinned down when necessary during the course of the experiment to prevent overcrowding. All fish were weighed once a week, and the amount fed was adjusted according to the feeding tables prepared by Deuel and Tunison (1944).

Diets were started on December 13 and were continued for 25 weeks in the better lots. The lots which broke down were terminated when growth and food-consumption had practically ceased.

All pertinent data obtained are shown in table 2.

The second column of table 2 shows which vitamins were lacking in the diet

of each particular lot. The omission of vitamin E from the diet of Lot No. 13 necessitated the use of lard instead of Crisco as the source of fat.

Before entering upon a discussion of the results, it is necessary to mention two circumstances which caused certain apparent discrepancies in the data. The first arose from an attempt to make use of vitamin-test casein in place of the ordinary casein, at the start of the 15th week, in all the lots which at that time showed no signs of breaking down. The fish refused to eat this casein (see section 1 of this paper), and therefore no growth resulted. In summarizing the growth data, the figures for 1 or 2 weeks had to be eliminated from these groups. The other circumstance was the appearance of an infectious bacterial disease in certain lots--a disease which caused mortality not attributable to the diet. This will be referred to again in the discussion of the mortality figures.

Duration of Experiment

From the third column of table 2, it is possible to determine which lots broke down and had to be terminated before the end of the 25 weeks. All such lots lacked pantothenic acid or folic acid.

Growth

Growth is reported in terms of weekly increase in the cube root of the average weight per fish in grams. This figure has been multiplied by 1,000 in order to eliminate decimals. In a normally growing fish, these figures should remain uniform indefinitely (Haskell 1948). In table 2, the figures are given as the averages for 4-week periods, except that the last figure is in most cases an average of only 3 weeks. A declining growth rate is reflected in declining figures. It will be noticed that the figures are all somewhat erratic, even where growth was still normal at the end. This lack of smoothness in the growth figures may be due to errors in weighing but more probably is attributable to other influences which could not be recognized.

It is clear from the data that the growth rate fell off very definitely in the two lots lacking pantothenic acid. This decline started after about 4 weeks. During the last 4 weeks, Lot No. 6 gained nothing and Lot No. 7 lost weight.

In all the lots which lacked folic acid, the growth likewise fell off, though not so abruptly as in those lacking pantothenic acid.

Lack of ascorbic acid, biotin, B_{12}, inositol, nicotinic acid, and vitamin E

TABLE 2.--Growth, erythrocyte count, and mortality of rainbow trout on experimental diets

Lot No.	Vitamins lacking	Weeks duration	Average weekly increase in $\sqrt[3]{\text{weight}}$ by 4-week periods*						Red cell count, thousands per cu. mm.**	Mortality by equal periods		
1	Liver diet	25	46	50	37	48	48	38	1,327 (5)	4	1	2
2	None	25	40	50	44	41	49	42	1,442 (5)	4	4	8
3	Ascorbic acid	25	49	51	47	36	51	41	1,585 (3)	6	3	3
4	Biotin	25	41	53	45	43	46	45	1,339 (5)	11	3	1
5	B_{12}	25	34	40	42	35	48	48	1,322 (6)	3	3	2
6	Pantothenic acid	19	38	38	7	0			Normal color	13	24	27
7	Pantothenic acid and biotin	19	34	29	4	-4			Normal color	15	9	27
8	Folic acid	21	33	32	15	14	12		1,053 (10)	2	12	19
9	Biotin and folic acid	21	31	31	18	10	11		1,109 (8)	9	17	30
10	B_{12}, biotin, and folic acid	21	37	29	10	7	7		1,115 (8)	6	18	38
11	Inositol	25	38	35	24	27	42	47	1,073 (5)	8	28	9
12	Nicotinic acid	25	37	48	43	35	42	36	1,341 (5)	8	0	4
13	E	25	38	52	52	36	37		Normal color	2	3	15

*Final period only 3 weeks in some lots.

**Number of fish on which average is based, is shown in parentheses.

did not interfere with growth within the time limits of this experiment. As small amounts of some of the B vitamins were introduced by the commercial casein, it cannot be concluded from these data that all the last-named vitamins are completely unessential for trout.

Mortality

Part of the mortality which occurred was due to the afore-mentioned bacterial infection, so that some of the figures require qualification. In reporting diet experiments, little is revealed by a single total-mortality figure, as in such experiments the particular part of the period in which losses occurred is extremely significant. A high early mortality, followed by a low later mortality, certainly has no significance as regards the effect of the diet. The reverse situation, in the absence of unrelated disease, is a significant reflection on the diet. These statements might seem obvious and unnecessary were it not for the fact that in most fishery literature the total mortalities alone are reported. Such a single figure is admissible, of course, where the losses are too low to have any significance. In table 2 the deaths are given for each of three equal periods, each figure being for one-third of the time the particular group was under observation.

In Lot No. 2, the higher mortality for the final period is attributed to the disease and not to the diet. Even in the absence of direct observations on fish, this conclusion could be reached from inspection of the figures for Lots No. 3, 4, and 5, for it would be difficult to accept the conclusion that the elimination of either ascorbic acid or biotin or B_{12} would improve the diet.

In Lots No. 2, 3, 4, 5, 11, 12, and 13, no increase in mortality attributable to the diets was observed, though the losses caused by the disease may obscure these conclusions in certain lots--as in No. 11 and No. 13. The only lots showing an increasing mortality rate are the lots which also showed a declining growth rate--Lots No. 6 to 10.

Erythrocyte Counts

Red-cell counts were made on a few fish from most lots at the end of observations. Lots No. 6, 7, and 13, unfortunately, had to be missed because of the pressure of other work. Inspection of the gills of fish from these three lots, however, showed them to have a normal red color, indicative of normal red-cell count.

All erythrocyte counts were made from blood obtained from the peduncle of the fish by bleeding onto a paraffined dish containing a few crystals of potassium oxalate. A certified Thoma red-cell blood-diluting pipette and a certified Spencer bright-line haemacytometer were used. Cells in both counting chambers were counted, and the average of the two counts was taken as the number of red cells per cubic millimeter of blood.

It will be seen that the red-cell count was quite as high on some of the synthetic diets as on the liver diet. Lack of ascorbic acid, biotin, B_{12}, and nicotinic acid, and probably pantothenic acid and vitamin E, did not depress the blood count. Lack of folic acid and lack of inositol brought on a mild degree of anemia.

Lesions

In all the fish, including those on the liver diet, there was a great deal of fin trouble. The pectoral fins were chiefly involved; on many fish these fins were almost gone. Because no lot escaped this condition entirely, nothing was learned of any relation to diet.

Many indefinite and ill-defined lesions appeared irregularly in different lots. Most fish which died toward the end of the experiment were examined, and a record was made of any pathologic condition. In addition, all lots were placed in a well-lighted aquarium and carefully scrutinized for abnormalities. Most of the data obtained were confusing and contradictory; with the exception of the two conditions noted in the following paragraphs, no conclusions could be drawn.

Gill disease appeared in the two lots

lacking pantothenic acid--and in no other lots. No bacteria could be observed on these gills. This confirms the writer's earlier report on the dietary origin of this form of the disease (Wolf 1945). Gill disease was not the sole cause of death in these lots, however, for moribund fish were found to be quite variable as to the intensity of the disease. Some fish, although unbalanced, exhibited only mild gill lesions, whereas in others the condition was quite severe.

The other fairly definite lesion noted was blue slime. This was found in five lots, those lacking pantothenic acid and those lacking folic acid. It was more severe in the former group. No other lots showed this condition.

Summary

The results of feeding trials in which vitamin-enriched synthetic diets were used for rainbow trout are reported. These trials lasted 25 weeks, and all conclusions are conditioned by the limited period involved. The following points have been demonstrated:

1. The synthetic diet used was equal to edible beef liver in ability to support growth and health in trout.

2. Pantothenic acid is an essential vitamin for trout. Its lack resulted in reduced food consumption, in growth stoppage, gill disease, and blue slime, but probably not anemia.

3. Folic acid is an essential vitamin for trout. Its lack resulted in reduced food consumption, in mild blue slime, and anemia.

4. Lack of inositol produced about the same degree of anemia as did lack of folic acid, but lack of the former did not interfere with the growth of the fish nor induce mortality during the period of observation.

5. No need was demonstrated for ascorbic acid, biotin, B_{12}, nicotinic acid, and vitamin E, although the use of commercial casein may have introduced sufficient quantities of the three B vitamins to satisfy the needs of the fish.

Acknowledgment

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LITERATURE CITED

Atwater, W. O., and Bryant, A. P.
1906. The chemical composition of American food materials. Bull. 28 (rev.), 87 pp. U. S. D. A., Off. Exper. Sta., Washington, D. C.

Deuel, C. R., and Tunison, A. V.
1944. Feeding tables for trout (revised). Mimeographed. N. Y. Cons. Dept., Bur. Fish, Albany, N. Y.

Embody, G. C., and Gordon, M.
1924. A comparative study of natural and artificial foods of brook trout. Trans. Am. Fish. Soc. 54: 185-200.

Haskell, D. C.
1948. Graphical method for presenting data on the growth of trout. Prog. Fish-Cult. 10 (2): 59-61.

Phillips, A. M., Jr.; Brockway, D. R.; Rodgers, E. O.; Robertson, R. L.; Goodell, Herbert; Thompson, J. A.; and Willoughby, Harvey
1947. The nutrition of trout. Cortland Hatchery Report 16, Fish. Res. Bull. 10, 35 pp. N. Y. Cons. Dept., Albany, N. Y.

Wolf, L. E.
1945. Dietary gill disease of trout. Fish. Res. Bull. 7, 30 pp. N. Y. Cons. Dept., Bur. Fish Cult., Albany, N. Y.

A METHOD FOR ENUMERATION OF SALMON AND TROUT EGGS BY DISPLACEMENT

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THE ACCEPTED hatchery methods for enumerating salmon and trout eggs are recognized, generally, to be grossly inaccurate. Of necessity, however, because no better technique has been developed, they have remained in use. Efforts of hatcherymen to duplicate previous measurements or to confirm the number of eggs received from other stations often show wide discrepancies. Many fish-culturists have been disconcerted, at times, by "underruns" or "overruns" among fingerling fish after conscientious efforts have been made to keep accurate records of the eggs received and of the subsequent mortalities. Most of these errors have stemmed from inaccuracies in the egg-measuring methods employed.

A displacement method of egg enumeration that has been developed has proved both practicable and accurate. This paper is concerned only with a description of the method. A subsequent report will deal with the accuracy of this procedure in comparison with other methods.

Description of the Displacement Method of Egg Enumeration

All methods of enumerating eggs involve two steps: (1) a determination of the volume or weight of the entire lot, and (2) the conversion of the volume or weight data obtained on the entire lot to actual numbers by a process of sampling.

The displacement method utilizes the water displaced to measure the volume of eggs. An initial volume of water (sufficient to cover the eggs to be measured) is introduced into a measuring container, eggs are added, and the final water level is read. The difference between the initial and final water levels is the actual volume of eggs measured. This method substitutes an easily and accurately read water level for an indeterminate egg level. Furthermore, utilization of a water level eliminates all need for agitating the container to settle the eggs.

The displacement method of sampling is merely an adaptation of the technique used for total measurement. Numerous 50-egg samples are selected at random from the eggs to be measured, and the volume of water displaced by each sample is determined by burette measurements. The fluid ounces of water displaced are converted to the number of eggs either by reference to a prepared table or by use of a formula. This technique has certain advantages over any other of the present methods. Accuracy is attained by use of the burette employed in the sample measurements. Because of the fine calibrations, a burette closely measures the size differences of the various samples. The character of the eggs at the time of measurement has no influence upon the accuracy of the calculations, as the conditions of the volumetric determinations duplicate those of the sampling technique.

The first step in the procedure of measurement involves the volume of water displaced by all the eggs. It is quite obvious, therefore, that the eggs must be adequately drained to eliminate the factor of extraneous water. A frame hung with bobbinet, approximately 2 feet long

and of proper width to fit over a trough, is admirably suited for draining the eggs. The eggs to be measured are poured onto the net and allowed to drain for at least 60 seconds. Toward the end of the draining period, the under side of the net should be gently wiped by hand to facilitate the removal of water. As trout and salmon eggs are not affected by short periods out of water, the net may be fully loaded.

Use of a perforated dipper is recommended for moving the eggs from the drain net to a measuring container. Any residual water clinging to the eggs will be removed in the dipper.

A standard 32-ounce graduate is used to measure quantities of eggs that displace 16 fluid ounces or less. It is necessary that the initial amount of water placed in the graduate be of sufficient quantity to cover the eggs completely and provide a clearly defined final water level. The larger the eggs, the larger are the interstices, and, consequently, the greater is the initial volume of water required. For large eggs, such as Chinook (Oncorhynchus tschawytscha), an initial volume equal to that of the eggs to be measured is required. For smaller sizes, the volume may be varied as found convenient, provided, of course, that a distinct final water level results.

A measuring can which automatically drains to the exact initial volume of water needed will facilitate the routine measurements of small quantities of eggs. All the equipment required for enumerating small quantities of eggs is illustrated in figure 1.

FIGURE 1.--The equipment necessary for measuring small quantities of salmonoid eggs by the displacement method includes: a measuring can for establishing the initial water level, a standard 32-ounce graduate, a perforated dipper, and a frame bobbinet for draining the eggs.

The techniques employed in measuring small or large quantities of eggs differ only in the size of the measuring containers used; the procedures for draining and handling of the eggs are essentially the same. Large quantities of eggs are put into a metal cylinder that is 7 inches in diameter and 16 inches in height, is equipped with a stopcock and calibrated glass gauge, and has a capacity of 160 "displacement ounces" of eggs. (See figure 2.) The initial water level is established at the zero reading on the gauge at a depth of approximately 6½ inches. The gauge is a standard 25-milliliter burette calibrated in tenths of milliliters. The conversion of the gauge readings to fluid ounces displaced is determined first by actual measurements of known volumes of water. All subsequent conversions are made by reference to the table attached to the cylinder: this table gives the conversion factor and shows the scale reading for each 10 ounces displaced.

In use, the cylinder is partly filled with water and the excess is drawn off through the stopcock until the gauge reads zero. Drained eggs then are added until any desired volume is attained. The cylinder should not be moved between the establishment of the initial and final water levels. The measured eggs are poured directly from the cylinder into the egg basket. The volume of water displaced by large quantities of eggs may be determined with speed and accuracy by this technique.

The second step in the enumeration procedure involves the determination of the volume displaced by a known number

FIGURE 2.--The frame bobbinet, the perforated dipper, and the measuring cylinder used in an adaptation of the displacement method for the measurement of large quantities of salmonoid eggs. The initial water level in the cylinder has been adjusted to the zero reading on the gauge.

FIGURE 3.--A 50-egg sample being introduced into the 50-milliliter burette by means of the counting trough. The funnel-shaped end of the trough facilitates the operation.

of eggs that are representative of the lot being measured. This step is necessary for transposing the volume of water displaced, as described in the foregoing section, into the numbers of eggs. The accuracy of the transposition between volume and numbers depends upon the selection of a number of random samples, for, obviously, the more numerous and representative are the samples, the more accurate will be the results. It is suggested that one or more random samples be taken as each volumetric measurement is made, and that a minimum of five samples be taken on any lot. For large lots of 500,000 to 2,000,000 eggs, the procedure may be altered to reduce the number of samples if proper precautions are taken to insure randomization and compensate for possible stratification. It is recommended that a sample of 2 to 4 ounces of eggs be selected from each basket of eggs measured. These "basket samples" are then incorporated into a single lot, and not less than thirty 50-egg samples are selected at random from the group. Accurate results may be expected if this technique is used.

The technique for sample measurements is merely the volumetric method adapted and refined for small samples. The equipment required includes a counting trough and a 50-milliliter burette clamped on a ring stand. The counting trough is 18 inches long, has a "V" bottom, and is curved to form a funnel at one end. (See figure 3.)

The first step in measuring the volume displaced by the sample is to fill the burette until the initial water level is slightly in excess of 25 milliliters. The egg sample is placed in the dry counting trough and 50 eggs are counted for measurement. It is essential that the counting trough be dry, as a single drop of excess water is measurable in the burette. Just before the eggs are added, the initial water level is adjusted to 25 milliliters. The eggs are introduced into the burette through the funnel-shaped end of the counting trough, and the final water level is read. As the burette is calibrated from the top down, the final water level (read in like manner) must be subtracted from the initial water level to determine the number of milliliters of water displaced. The number of eggs

per fluid ounce of water displaced may be calculated by dividing the number of milliliters per ounce (29.573) by the number of millliliters of water displaced, and then multiplying the quotient by the number of eggs in the sample. For ready reference, the necessary calculations have been made for 50-egg samples and are given in the accompanying conversion table. For purposes of uniformity, all readings in the burette should be made at the bottom of the meniscus.

It is suggested that when computing the number of eggs per fluid ounce of water displaced (which is derived from the average of all the samples), the number of eggs per ounce of water displaced be recorded for each sample. The sum

CONVERSION TABLE

MILLILITERS OF WATER DISPLACED BY 50 EGGS CONVERTED TO NUMBER OF EGGS PER DISPLACEMENT OUNCE

Milliliters displaced	Number per ounce	Milliliters displaced	Number per ounce	Milliliters displaced	Number per ounce
3.0	492.88	7.1	208.25	11.2	132.00
3.1	477.00	7.2	205.35	11.3	130.89
3.2	462.10	7.3	202.55	11.4	129.70
3.3	448.10	7.4	199.80	11.5	128.60
3.4	434.90	7.5	197.15	11.6	127.45
3.5	422.45	7.6	194.55	11.7	126.40
3.6	410.75	7.7	192.05	11.8	125.30
3.7	399.65	7.8	189.55	11.9	124.25
3.8	389.10	7.9	187.15	12.0	123.20
3.9	379.15	8.0	184.83	12.1	122.20
4.0	369.65	8.1	182.55	12.2	121.20
4.1	360.65	8.2	180.30	12.3	120.20
4.2	352.05	8.3	178.15	12.4	119.25
4.3	343.85	8.4	176.05	12.5	118.30
4.4	336.05	8.5	173.95	12.6	117.35
4.5	328.60	8.6	171.95	12.7	116.45
4.6	321.45	8.7	169.95	12.8	115.50
4.7	314.60	8.8	168.05	12.9	114.60
4.8	308.05	8.9	166.15	13.0	113.75
4.9	301.75	9.0	164.30	13.1	112.85
5.0	295.75	9.1	162.50	13.2	112.00
5.1	289.95	9.2	160.70	13.3	111.20
5.2	284.35	9.3	159.00	13.4	110.35
5.3	279.00	9.4	157.30	13.5	109.55
5.4	273.80	9.5	155.65	13.6	108.70
5.5	268.85	9.6	154.05	13.7	107.95
5.6	264.05	9.7	152.45	13.8	107.15
5.7	259.40	9.8	150.90	13.9	106.40
5.8	254.95	9.9	149.35	14.0	105.60
5.9	250.60	10.0	147.85	14.1	104.85
6.0	246.45	10.1	146.40	14.2	104.15
6.1	242.40	10.2	144.95	14.3	103.40
6.2	238.50	10.3	143.55	14.4	102.70
6.3	234.70	10.4	142.15	14.5	102.00
6.4	231.05	10.5	140.80	14.6	101.30
6.5	227.50	10.6	139.50	14.7	100.60
6.6	224.05	10.7	138.20	14.8	99.90
6.7	220.70	10.8	136.90	14.9	99.25
6.8	217.45	10.9	135.65	15.0	98.60
6.9	214.30	11.0	134.40		
7.0	211.25	11.1	133.20		

$$\text{Number of Eggs per Displacement Ounce} = \frac{29.573}{\text{Mls. of Water Displaced}} \times \text{No. of Eggs}$$

of the group divided by the number of samples will give the average number of eggs per ounce. This procedure eliminates the necessity for repeated interpolation in the table, a possible source of error.

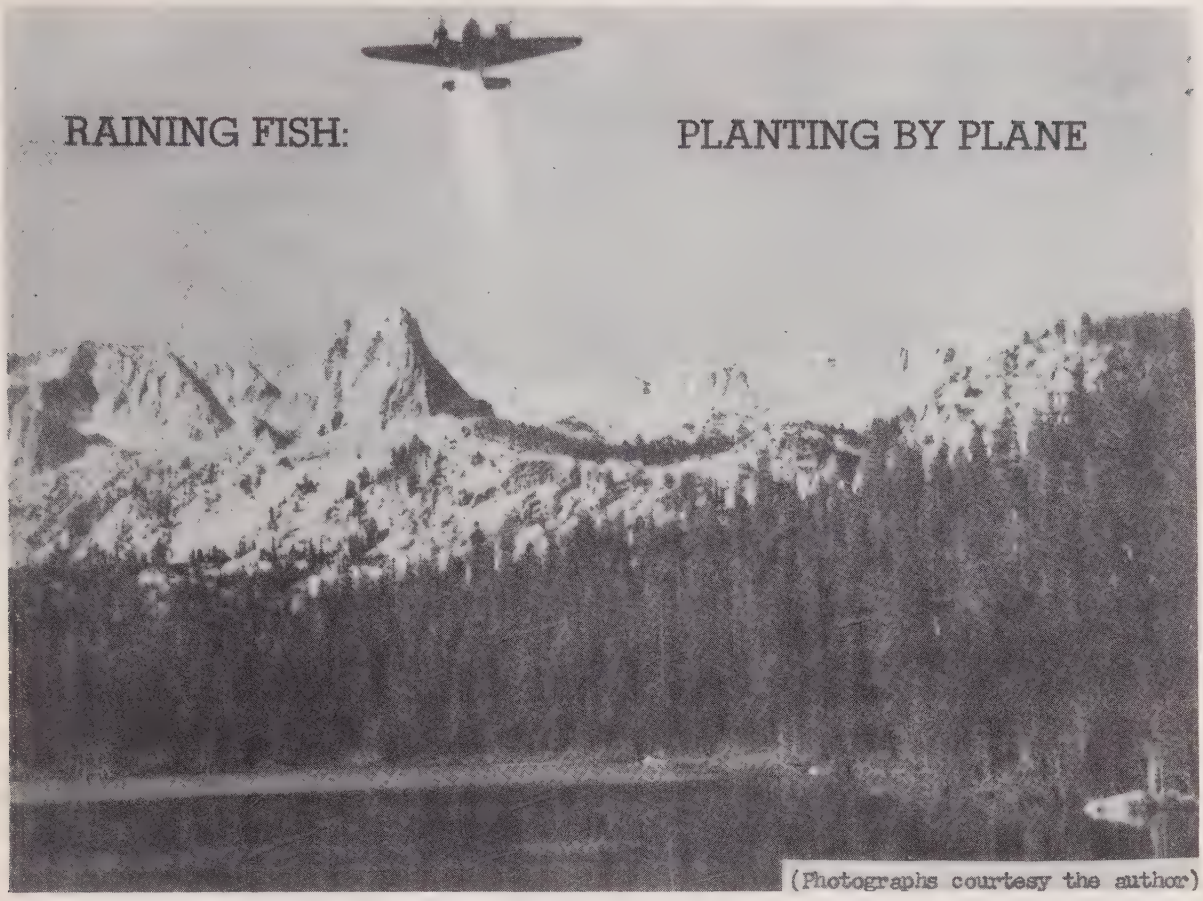
There is a tendency among hatcherymen to use the predominant sample in a lot as indicative of the size of the eggs in that lot. This procedure is not statistically sound and should be avoided. Every random sample from a lot of eggs must be included in the calculations to establish an accurate average.

Summary

A displacement method has been developed to enumerate salmonoid eggs. This technique utilizes the volume of water displaced by the eggs. Two steps are involved in the technique: (1) measurements to determine the volume of water displaced by all the eggs and (2) sampling to determine the number of eggs per fluid ounce of water displaced. This technique substitutes an accurately read water level for the indeterminate egg level and provides a method for accurate measurements. The sampling technique, devised for the determination of the number of eggs per fluid ounce of water displaced, exactly duplicates the conditions of the volumetric method and thus automatically compensates for changes in the character of the eggs.

The northern pike, traveling through new fishways, may dethrone King Muskellunge in certain fishing waters. The young of the pike hatch earlier than the muskellunge progeny, so that the pike are able to devour the younger and weaker muskellunge.

Scientists are now looking into the possibility of utilizing odors to influence adult salmon upon their return to spawning streams. "Even your best friend won't tell you" is a slogan that has attracted millions of people to the extent of millions of dollars, but bait manufacturers may find it difficult to devise an equally effective appeal to the better nature of fish.



A cargo of fingerlings released from the airplane, the water is instantly converted to mist, and the fish drop into the lake.

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RAINING FISH from the sky is a phenomenon supposedly witnessed by only a few individuals and is usually ascribed to the recklessness of old Jupiter Pluvius. By some disbelievers it is attributed to the morning-after hangover, with full credit to John Barleycorn. Debatable as this may be, raining fish in California has become a routine fish-planting operation and has already been witnessed by many.

An unusual incident was the case of two anglers who, while fishing from a raft in a small lake in Siskiyou County, found themselves in the target area as the twin-engined airplane owned and operated by the California Division of Fish and Game swooped down and narrowly missed them with its discharged cargo of finny, fluttering fingerlings.

Experiments in airplane fish-planting have been carried on by Federal and State agencies for several years, many dating before the beginning of World War II.

See also:

Garlick, L. R.
1950. The helicopter in fish-planting operations in Olympic National Park. Prog. Fish-Cult. 12 (2): 72-76.

Hoses from a motor-driven compressor provide aeration during the plane trip. Detachable hopper is shown on the left.

Experiments have been varied, involving amphibious, conventional aircraft and the helicopter. Methods have now advanced to the extent that the airplane has become a permanent implement in fish-hatchery operation insofar as fish planting is concerned.

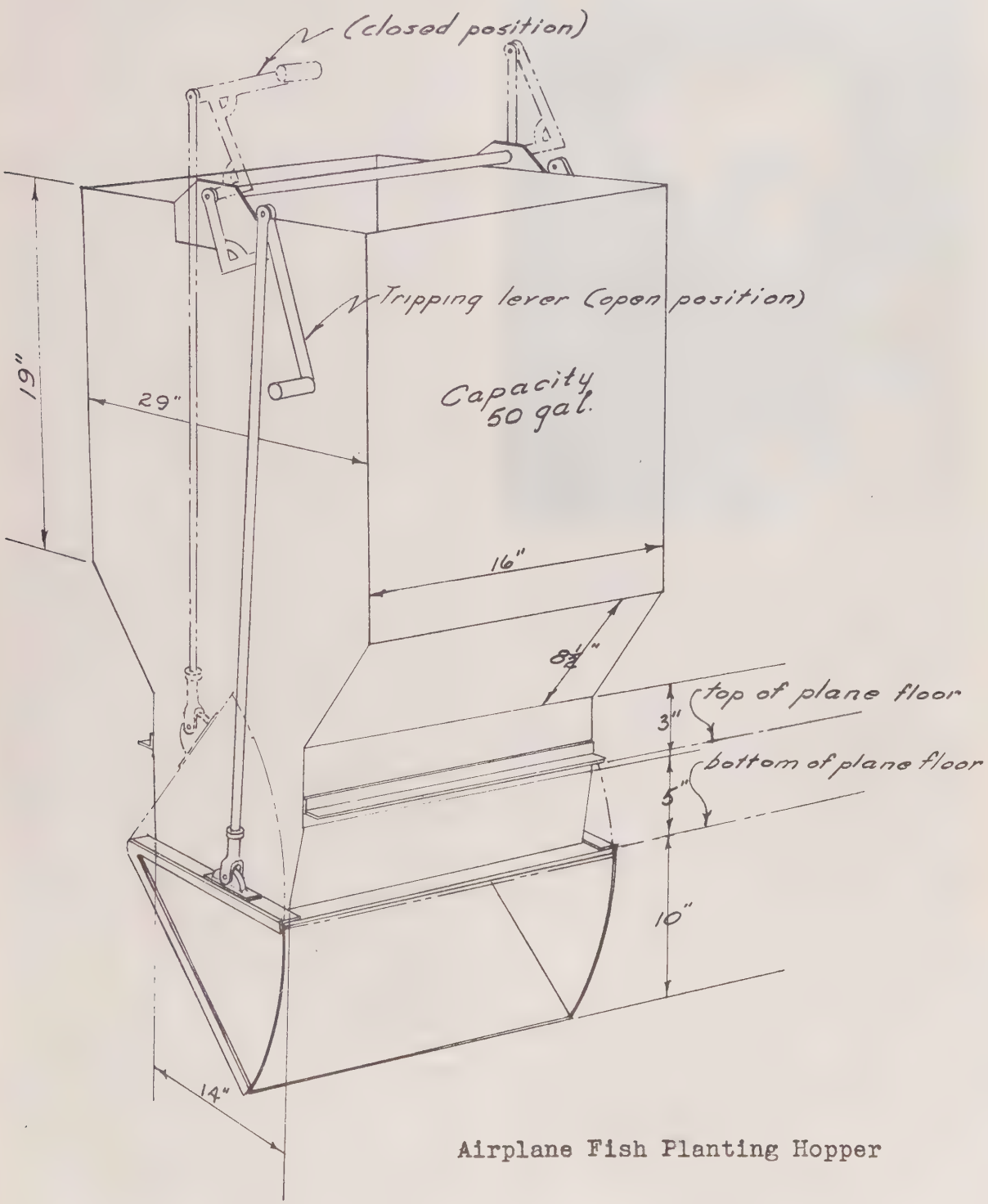
Airplane fish-planting experiments were first undertaken by this Division during the summer of 1946 and continued in 1947. The first practical application was made in 1949, when 300,000 fingerling trout were dropped into 150 lakes which could not be reached by planting truck. A full-scale planting program was undertaken in 1950, when 1,583,000 fingerlings were planted in 415 lakes in 82½ hours of flying time.

The first experiments were conducted with a 165-horsepower single-engine monoplane. Though this small airplane was not the most suitable for this type of work, it was used for considerable experimentation with various methods. Fish were dropped in 5-gallon ice cream containers with bottom seams waxed and both with and without lids, in 5-gallon tin cans with circular opening and no lid, and in waxed ice cream containers slung with shroud lines of a canopy chute; fish were also dumped directly from the airplane.

All experiments were conducted at a location where the fish dropped could be recovered, results could be carefully observed, and an accurate account of each experiment could be recorded. After two seasons of experiments, it was clearly demonstrated that the free-fall method, whereby the fish are released or poured from the airplane without use of containers, is the most practical.

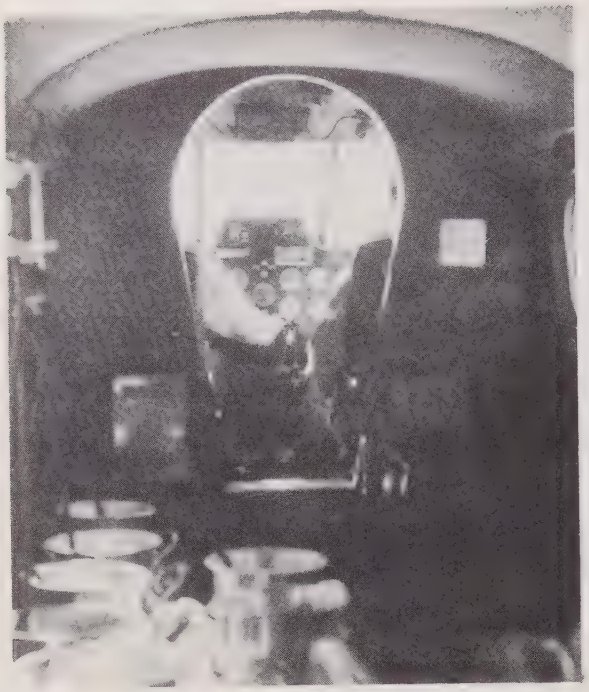
Experiments in free-fall planting have proved that trout as much as 4 inches in length, averaging two per ounce, can be dropped with 100 percent survival. Catchable trout, from six to eight per pound, showed a survival of 85 percent; adult trout, 15 inches in length, were killed by the impact. The most suitable height from which fingerlings can be freely dropped without injury--yet allowing sufficient altitude for sighting on the target, maneuvering the airplane, and providing ample safety for the airplane and crew--is between 300 and 800 feet, the speed of the airplane being around 120 miles per hour.

Early in 1949, for use in patrol and other work, this Division acquired a Model C-45 Beechcraft, powered with two 450-horsepower Pratt and Whitney engines. This airplane was soon equipped for fish planting.



Airplane Fish Planting Hopper

Installed in this airplane is a 6-inch diaphragm compressor driven by a small 24-volt electric motor and operated from the plane's storage batteries. This compressor has sufficient capacity to provide aeration for 40 cans. Only 16 air hoses are attached to the compressor discharge, however, because usually from 8 to 15 cans are carried and the hoses are distributed one to each can and one to the



Fifteen all-aluminum cans are arranged in the interior of the plane, convenient to hopper in forward right corner.

planting hopper.

The floor of the fuselage has been cut through, and two openings have been made. One rectangular opening (16 by 18 inches) provides for placement of a fish-planting hopper and allows for alternative installation of a K-22 camera which is used in aerial survey and game census work. A small opening (4 inches square) immediately behind the hopper location provides for installation of a range finder and allows for sighting on the lake that is to be planted.

The fish-planting hopper is made of aluminum of crimped seam and welded construction. It is 16 inches wide, 29 inches long, and 32 inches in over-all height, and has a water capacity of about 50 gallons. The bottom opening (14 by 16 inches) is hinged on the forward side and fitted all around with watertight gaskets. The bottom is operated by a hand lever, and the entire content of water and fish is instantaneously released when the tripping lever is pulled down.

Other containers used in airplane fish-planting are aluminum cans that closely resemble regular 10-gallon milk cans. Being made entirely of aluminum, however, these fish-planting cans are much lighter in weight; they are also shorter and slightly larger in diameter--in order to prevent their being upset in rough travel.

For planting by airplane, the fish are normally delivered to the airstrip in regular 10-gallon milk cans and are poured into the 10-gallon aluminum cans before being placed on the airplane. About 90 ounces of fingerlings are placed in each aluminum can, which is immediately transferred to the airplane. Usually eight of the aluminum cans (each can and contents weighing 80 pounds) are carried.

As the airplane approaches the lake where the fish are to be dropped, excess water is drained (into an empty can) from the number of cans required for the plant. The contents of these cans are then poured into the hopper, which also is being aerated by the compressor. In this manner the fish are quite heavily concentrated for 2 to 3 minutes before their release but are kept in good condition by proper aeration.

Airplane fish-planting in the mountainous area of California requires a reliable, sturdy airplane with ample power and a service ceiling of not less than 20,000 feet. The pilot and co-pilot must be experienced and must know how the airplane will handle with its cargo and under the conditions in which these flights are made.

Prior to actual planting, a reconnaissance flight should be made over the area in which the planting is to be done. Lakes should be located and the proper method of approach worked out. Those lakes which cannot be planted should be noted. The location of lakes is sometimes difficult. Area maps are usually valuable only in locating drainages and are not reliable for this work, as small lakes often are not shown. Aerial photographs are far more useful. A person who has visited the lakes from the ground has a great advantage and, with the aid of aerial photographs, can locate the lakes quite readily.

Airplane fish-planting is best carried on during the calm and clear of the early morning, usually between the hours of 4 a.m. and 10 a.m. Usually a first flight

at a higher altitude is made over the lake to be planted, and then the planting run is made. Small lakes are passed over in a matter of a few seconds, and proper approach and careful sighting are necessary. When coming in over a lake, the person who operates the tripping mechanism stands behind the hopper and sights straight down through the small 4- by 4-inch hole directly behind it. The tripping lever is pulled the instant the lake comes into view. When the tripping mechanism is opened, the fish and water are literally sucked from the hopper. The hinged bottom of the hopper moves down and forward, forming a small 12- by 16-inch flap. This, plus the instantly reduced load, causes the airplane to bounce upward about 20 feet the instant the tripping lever is pulled.

The water is at once converted to mist by the propeller wash and resembles a small puff of white smoke. The fish have a trajectory of only about 200 feet, after which they fall straight down at the rate of about 50 feet per second or approximately 28 miles per hour. They tumble this way and that, and only occasionally does one fall head-first. It does not seem to matter how far above the lake the fish are released--they will always fall in the same pattern and area in the lake unless they are drifted by the wind. The accuracy with which the target area can be hit is most surprising. After a few trial runs, an experienced pilot and assistant can score a bull's eye on small lakes having a surface area of only 2 to 3 acres. Observation made under actual planting conditions showed that the fish, after dropping into the lake, made a wild rush for shallow water and then quieted down.

During the 1949 season, the highest lake planted was in the Mt. Whitney area. This lake lies at an elevation of 13,600 feet. The longest haul from take-off point to planting location and return was 140 miles, requiring 55 minutes of flight time. The largest number of fingerlings dropped at one time was 10,000. Most drops were made from an elevation of about 500 feet.

The airplane affords many advantages over pack-stock planting. Some of these advantages may be summarized as follows:

1. Lakes can be planted early in the season, before trails are open and while surface temperatures are most suitable.
2. Fish can be placed in the lake at a time when food is increasing and good growth and survival are assured.
3. The time saved is in itself a desirable feature. The cost of hatchery operation is reduced in that a planting program normally requiring from 60 to 90 days can be completed in 8 to 10 days.
4. The cost of operating the airplane, including pilot and co-pilot, is figured at $32 per hour. The cost of planting 165,000 fish, including cost of trucking personnel, was $658.04, or $3.98 per thousand. This compares favorably with $19.80 per thousand last season, when 377,600 fingerlings were planted with pack stock at a cost of $5,511.50.

You must lose a fly to catch a trout.--Herbert.

EYED BROOK TROUT EGGS PLANTED IN MAINE FARM PONDS

Plantings of 600 eyed brook trout (Salvelinus fontinalis) eggs were made in each of five separate pond areas in northern Maine during the winter of 1949. These plantings were made through the cooperation of the Fish and Wildlife Service, the Soil Conservation Service, and the University of Maine, as preliminary work in determining the feasibility of using eyed eggs to stock farm ponds in this area. Though the experiment cannot be carried further at this time, the results reported by Carll N. Fenderson of the Department of Zoology of the University of Maine are of general interest.

Two of the plantings were made in small inlets to farm ponds, one was made in a large well-type spring, and two were made directly on pond bottoms in 3 to 4 feet of water. Water temperatures ranged from 0° in the spring to 3° C. on the pond bottoms.

The five plantings were enclosed in five wire cages, 20 by 20 by 12 inches, constructed of wooden frames with galvanized-wire screening. For each of the two pond-inlet plantings, a cage was set several inches into the stream bed and an artificial redd of coarse gravel was constructed inside the cage. When released, the eggs settled to the bottom of the redd, much as they would have in the wild. The eggs of the three other plantings were spread out on standard brook trout hatchery trays mounted on small metal legs and placed over 3 inches of coarse gravel on the cage-bottoms. The eggs remained undisturbed on the trays when the cages were lowered through holes in the ice to the pond bottoms selected.

Both plantings in the inlets were unsuccessful, probably because of silt. One of the plantings on a pond bottom was destroyed by children. The planting in the well-type spring had a hatch of 560 eggs, and the planting on the second pond bottom showed a hatch of 588 eggs.

To produce efficiently, a body of water should contain more than one species of fish. The owner who plants only bass (or other carnivorous fish) in his pond will certainly have larger and larger fish--but fewer of them.

THE HANDLING OF APPLICATIONS FOR FISH IN THE FISH AND WILDLIFE SERVICE

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A GREAT DEAL of manual effort was formerly required for the handling of Federal applications for fish. As the number of applications received by the Fish and Wildlife Service increased from 11,695 in 1941 to 53,232 in 1947, it became evident that an improved system of handling and processing applications was required. Until the present system was inaugurated in 1949, the application form utilized by the Fish and Wildlife Service and its predecessor, the Bureau of Fisheries, followed essentially the pattern set by the old Commission of Fish and Fisheries (organized in 1871). As this form had been designed purely for manual processing, the amount of clerical labor involved in handling the present-day number of applications was tremendous.

In the search for a better method of handling the greatly increased work load, the Service called upon representatives of the International Business Machines Corporation to devise an improved form that could be processed by means of I.B.M. equipment. As a result of this consultation, a card form was drawn up for the application for fish. The proposed card form was critically analyzed and revised to meet long-range requirements. This application form is a folder consisting of two identical cards, 3-1/4 by 7-3/8 inches. The folded edge is perforated to permit separation of the cards. Applicants complete the cards in duplicate--a great saving of clerical labor in the Service.

On the face of the application, under the heading "Application for Fish," applicants answer simple, self-explanatory questions concerning the waters to be stocked. When the form is received from an applicant, the information given on the face of the card is carefully analyzed, as this information provides the basis for assignment of the species of fish.

The reverse side of the application carries spaces for the designation of sponsorship by Federal agency or other source, action by State fishery department, and other data concerned primarily with the processing of the application.

As a result of installing the I.B.M. equipment, the preparation of statistical data has been expedited. Typical tabulations prepared by these machines are as follows:

1. Periodic summaries of species of fish distributed from Federal hatcheries.
2. Summaries of fish and fish eggs assigned to Federal agencies.
3. Assignments of fish and fish eggs to State fish commissions.
4. The annual output of Federal fish-cultural stations.
5. Annual summaries of fish distributed within each State.
6. Annual summaries of fish distributed within each Region.
7. Annual summaries of fish distributed within watershed areas, as the Tennessee and Missouri Rivers.
8. Annual assignments of fish and fish eggs to foreign countries and U. S. possessions.

Data under these eight headings are tabulated and published by the Service,

thereby providing permanent records that are useful to this agency, the State conservation departments, and the general public.

The new system of handling applications has facilitated the interpretation of data on applications filled during 1949, as in tables 1, 2, and 3.

The extensive demands for Federal fish cover requests to fill the needs of various waters within particular geographical areas. Salmon production is the primary activity at the Federal hatcheries in Region 1. The propagation of salmon involves large-scale operations relative to the restoration and maintenance of runs of this species where dams or other structures have destroyed, impaired, or blocked access to spawning grounds. The production of trout in Region 1, although secondary to salmon in volume, represents extensive operations involving principally the stocking of waters under the jurisdiction of the National Park Service and the Forest Service. The greater part of the trout production is distributed in accordance with planned restoration and management programs. Inasmuch as the salmon and trout distribution is generally confined to hatchery plants of large numbers of fish, the total number of applications handled is smaller than in other regions. Warm-water species are propagated at only one hatchery in Region 1.

Regions 2, 3, 4, and 5 receive extensive demands for warm-water fish to stock farm ponds and other impoundments. The warm-water species produced, including predaceous and forage fish, are stocked in combination, as experimentation has

TABLE 1.--Sponsorship of applications during 1949

Sponsor	Number of applications
Soil Conservation Service	23,116
Agricultural Extension Service	5,582
Indian Service	108
Forest Service	551
National Park Service	26
Fish and Wildlife Service	33
National Defense	56
Veterans Administration	4
Foreign (Canada)	1
	29,477
State agencies	3,655
Hatchery plants	1,613
Individuals	9,702
Clubs	2,634
	47,081
Transfers among Federal hatcheries	265
	47,346

TABLE 2.--Types of water stocked during 1949

Type of water	Number stocked
Farm ponds, rearing ponds, hatchery ponds, etc.	38,167
Lakes	3,466
Streams, creeks, rivers, etc.	5,064
Marine	649
	47,346

For administrative purposes, the Fish and Wildlife Service groups the States into five Regions:

Region 1 -- California, Idaho, Montana, Nevada, Oregon, and Washington.
Region 2 -- Arizona, Colorado, Kansas, New Mexico, Oklahoma, Texas, Utah, and Wyoming.
Region 3 -- Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Nebraska, North Dakota, South Dakota, and Wisconsin.
Region 4 -- Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, and Virginia.
Region 5 -- Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Vermont, and West Virginia.

--The EDITORS

TABLE 3.--Extent of stocking during 1949

Region	Waters stocked				Application totals	Fish distributed	
	Farm ponds	Lakes	Streams & rivers	Marine		Number	Weight (pounds)
1	21	237	421	-	679	69,588,745	297,997.0
2	7,289	706	623	-	8,618	40,784,070	72,252.4
3	4,718	1,597	894	-	7,209	25,742,830	77,253.9
4	23,215	582	604	-	24,401	31,306,598	96,254.7
5	2,924	344	2,522	649	6,439	583,103,607	137,592.8
	38,167	3,466	5,064	649	47,346	750,525,850	681,350.8

revealed that such species should be so stocked in order to maintain a balance in the fish population. Because of the great increase in the construction of farm ponds and other impoundments, it has been necessary to produce large numbers of relatively small pondfishes to meet these requirements. The extent of the demand for fish for farm ponds is indicated by the fact that 80 percent of all applications filled (table 2) dealt with the stocking of ponds. Requests for fish to stock farm ponds in the southeastern States (Region 4) were particularly numerous, as is reflected in the number of applications listed under this category in table 3. Trout are produced for stocking heavily fished streams, for maintaining stocks in lakes, for introduction into barren waters, and for restocking waters in which the population has been destroyed by winterkill or by some other factor. Trout are in demand principally for planting in heavily fished streams for almost immediate recapture. In the densely populated areas within the Middle Atlantic and New England States (Region 5), there is an enormous demand for trout to meet the requirements for sustaining put-and-take fishing. This makes it necessary for hatcheries to rear trout to legal size, thereby emphasizing weight-production. Tabulations such as tables 2 and 3 are valuable for an appraisal of the nature and extent of the demand for fish throughout the country.

The processing of applications for fish is outlined in the flow chart (figure 1). The following paragraphs, A through J, have reference to the steps so designated on the chart.

A. The application supplied to anyone who requests fish is completed in duplicate by the applicant--one application for each body of water to be stocked--and is submitted to the Washington office of the Service. The date of receipt is stamped on the application.

B. The fishery-management biologist assigns the species or combination of species suitable for stocking the particular type of water in question. This assignment is based upon a comprehensive knowledge of management and stocking programs developed by Federal agencies and State fishery authorities.

C. A clerk puts a serial number on both copies of the application and enters on the duplicate copy the codes prescribed for designating various types of information.

D. With 40 of the States, the Service has agreements stipulating that the State shall review any application for Federal fish to be stocked in water within that State. This review of Federal applications enables the States to determine the propriety of stocking the designated waters with the species requested, as related to fishery-management programs developed by the States. Such a review also promotes more efficient utilization of the production of Federal and State hatcheries by preventing duplication of effort. Therefore, in accordance with existing agreements, any application originating from one of these 40 States is forwarded to the applicable State fishery authorities for recommendations or comment. (A Service-approved application that need not be cleared with a State is prepared for mailing to the proper regional office.)

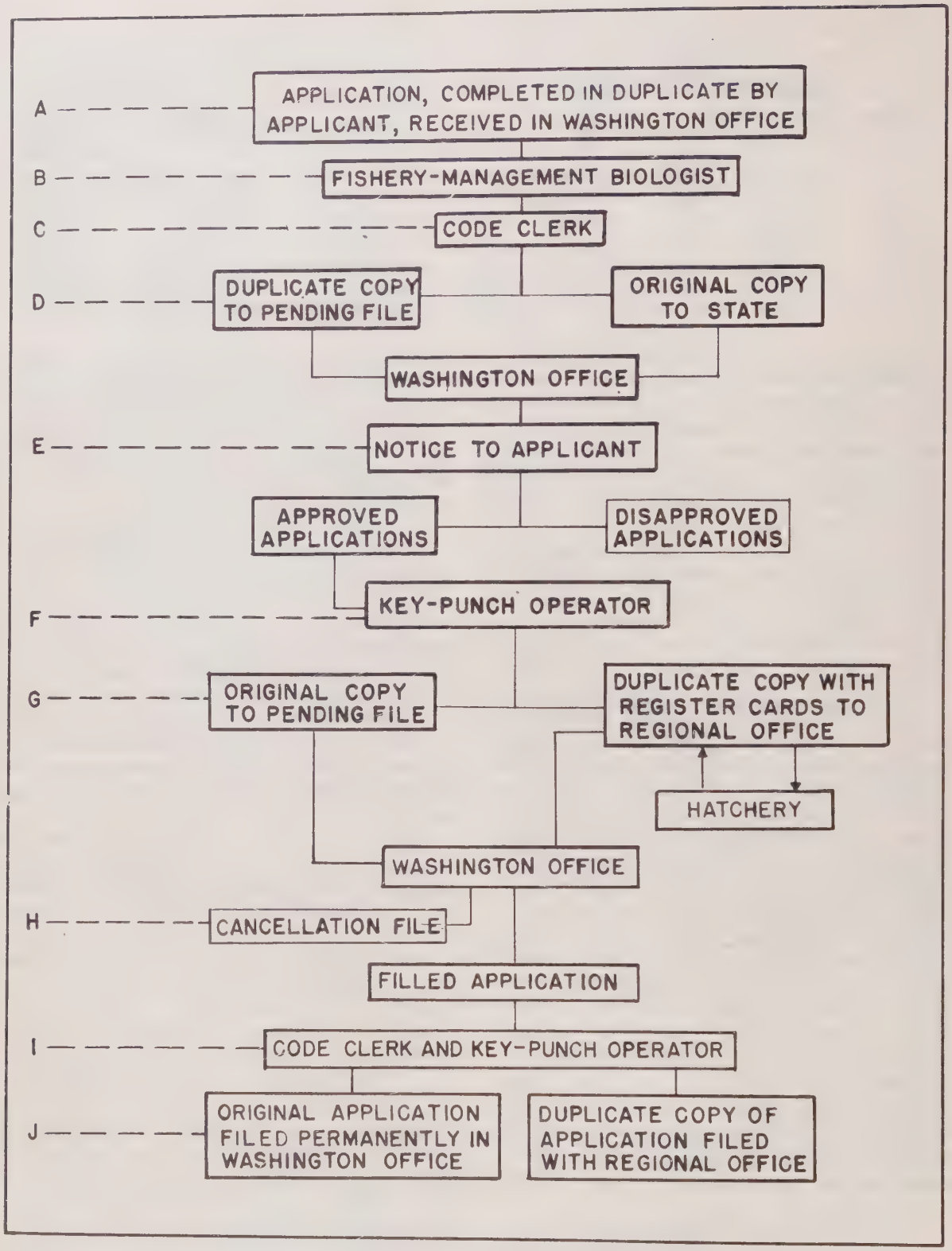


FIGURE 1.--The flow chart. (See text.)

E. When review by the agencies concerned has been completed, the applicant is notified of the approval or disapproval of his application.

F. Two register cards are prepared for every approved application. These cards contain the serial number of the application, the name of the applicant, and the name and location of the waters.

G. The duplicate of the approved application and the two register cards for it are sent to the proper regional office for transmittal to the delivering hatchery. The original of each application is retained in the Washington office.

H. When the fish have been delivered, the superintendent of the fish-cultural station enters data relative to the shipment on the reverse side of the application, retains one register card for the station records, and sends the other card and the filled application to the regional office. That office retains the register card and transmits the filled application to the Washington office. If, for some reason, delivery of fish cannot be made, the superintendent of the fish-cultural station routes the application to Washington for cancellation.

I. A clerk codes the filled application for punching operations. A key-punch operator prepares a statistical card for each species of fish delivered on an application. This card is used for preparing the various statistical tabulations that are required. For example, when a report of the fish distributed within a State is required, the statistical cards are machine-sorted by States, counties, species, etc., and then tabulated on the I.B.M. electric accounting machine. This procedure is followed for whatever type of report is required.

J. After the data relative to the shipment of the fish are extracted from a filled application, the application card is filed alphabetically by name of the applicant under the proper State. These filled applications carry a complete description of all waters stocked, thereby providing information that is useful to Service biologists. The filled applications are also referred to when the Service receives inquiries relative to the species and numbers of fish delivered to some applicant, or requests for information relative to some body of water that may be of interest to biologists.

One purpose of the operations and procedure in connection with the handling of applications, as outlined, is to provide information concerning the status of applications at any point during their processing. It has been indicated that the Service receives applications that are sponsored by other Federal agencies, as well as applications from many individuals and sportsmen's organizations. The interest on the part of the sponsoring agencies and individuals in connection with acquiring Federal fish results in an enormous volume of correspondence with those who desire information concerning the status of deliveries of fish. The ability of the Service to furnish this information promptly assists in maintaining amicable relations with those who desire fish for stocking purposes. The systematic processing of requests for fish is also necessary to facilitate the routing and handling of applications that are submitted to State authorities for review and recommendations. Finally, the organized procedure relative to the allocation of requests to the Regions and the return of the filed applications, makes it possible to evaluate the production performance of the individual hatcheries, to accumulate statistical data that are useful for budget-preparation purposes, and to provide promptly information that is required of this Service from time to time.

The Service has found that this system of handling applications for fish is a practical and efficient means of managing this phase of its work. Since the system has been in effect, it has become evident that further improvements and changes in techniques can provide a still wider range of useful information and expedite still more the processing of statistical data. These further changes will be incorporated as the need arises.

COMMENTS

State Fish Hatchery
Rome, New York
September 8, 1950

The Editor
THE PROGRESSIVE FISH-CULTURIST
Fish and Wildlife Service
Washington, D. C.

Dear Sir:

In the July 1950 issue of THE PROGRESSIVE FISH-CULTURIST there was a warning to users of pyridylmercuric acetate. I would like to issue another warning. It concerns the use of this very valuable drug on rainbow trout.

For several years we have been using this compound in the hatcheries of New York State. We have employed the following dosage schedule, which allows for short treatments in troughs as well as more extended treatments in ponds:

	Concentration		
Minutes	Parts	or	Grams per cubic foot of water
10	1: 20,000		1.416
15	1: 30,000		0.944
20	1: 50,000		0.566
30	1:100,000		0.283
40	1:150,000		0.189
60	1:250,000		0.126
90	1:500,000		0.057

Water temperatures have not been considered in this schedule, as the treatments have proved safe and effective at all temperatures at which our trout hatcheries normally operate.

We have treated very weak Atlantic salmon, lake trout, brook trout, and brown trout repeatedly--never with any appreciable loss from the treatment, and always with excellent results when the fish were suffering from uncomplicated bacterial gill disease. We have had no experience in treating rainbow trout, for we raise comparatively few of these in New York, and those we have raised have been free from this disease.

This past summer the foreman of one of our hatcheries treated his brook trout fingerlings for bacterial gill disease. The fish were in troughs, and the 20-minute treatment was given. As usual, the treatment was very successful. At this time, however, the hatchery had six troughs of rainbow trout which showed no signs of gill disease and were having no losses. Although these fish seemed perfectly healthy, it was decided to treat them along with the brook trout, just in case the rainbows might be harboring gill bacteria. The rainbow trout stood the immediate treatment very well, but about an hour later they started turning over. After this they rapidly began dying, and by the end of the day the loss was almost total.

It thus appears that a treatment which the weakest salmon, and most species of trout, can stand is not tolerated by perfectly healthy rainbows. We have never encountered any such tremendous species difference with any other drug used in disease treatments, though small differences in drug tolerance are doubtless common.

Very truly yours,

Louis E. Wolf.

EFFECT OF BACTERICIDES ON STEELHEAD TROUT FRY

R. R. Rucker and W. J. Whipple
U. S. Fish and Wildlife Service
Winthrop, Washington

MORTALITY among the blueback salmon (Oncorhynchus nerka) fingerlings at the U. S. Fish-Cultural Station at Winthrop, Washington, made it necessary to consider the advisability of using prophylactic treatments before the fish had reached the fingerling stage. Because blueback salmon were not available at this time, experiments with a few bactericides were run on steelhead trout (Salmo gairdnerii) fry to determine their resistance.

A few of the blueback salmon eggs taken in 1949 were retained at the Winthrop Station, but the majority were taken to the Leavenworth (Washington) Station for rearing. At Winthrop a high mortality developed among the fry and fingerlings from these eggs. At Leavenworth no unusual mortality was observed. When the fingerlings were feeding well, some of these fish were returned from Leavenworth to Winthrop. This transferred group experienced no unusual mortality at the Winthrop Station, whereas the original stock that had been held at Winthrop continued to die. It was believed possible, therefore, that a bacterial infection had developed in the fish when they first hatched--apparently a very critical stage in the life of a fish.

A pathogen was isolated only by indirect means. Young diseased fish were ground up and injected into healthy yearling blueback salmon. A fluorescent Pseudomonad, which was shown to be pathogenic to fish, was recovered from these yearling bluebacks. No pathogens were obtained directly from the very young fish.

At the present time, weekly prophylactic treatments are not started at the Winthrop Station until the fish are eating well. In making plans for next year's blueback salmon hatch, it was desired to give prophylactic treatments to the fry. As steelhead fry were available in a series of age groups, these were subjected to the bactericides to determine whether the fry were less resistant than the fingerlings.

During the first experiments there was mortality among the 2-day-old fry, including the control group. It was then realized that very young fry cannot stand much shock from handling. The experiments were repeated three more times, and rough handling was avoided to prevent shock. No mortality developed in the control groups. The following conclusions were derived:

1. A 3-percent salt treatment for 1 hour was toxic to steelhead fry that were 1 to 2 weeks old. The treatment was not toxic to older fry nor to 3-inch blueback salmon.

2. Roccal at a 1:50,000 dilution of the 10-percent commercial solution for 1 hour, judged from the results, probably was not toxic to the fish tested.

3. Pyridylmercuric acetate at a concentration of 1:100,000 for 1 hour was not toxic to the steelhead fry tested nor to the 3-inch blueback salmon. H. E. Johnson, biologist at the Coleman (California) Station, indicated in a personal communication that pyridylmercuric acetate at a concentration of 1:200,000 for 1 hour was not toxic to steelhead (rainbow) trout fingerlings less than 3 inches in length, but was toxic to larger fingerlings of this species.

4. Malachite green at a 1:200,000 concentration for a half hour was not toxic to the steelhead

trout fry nor to the 3-inch blueback salmon fingerlings. However, a 1-hour exposure, which is used successfully as a semiweekly treatment during the fry stage at the Coleman Station, showed slight evidence of being toxic to the young steelhead fry and was definitely lethal to the 3-inch blueback salmon fingerlings.

The bactericidal action of roccal, malachite green, and pyridylmercuric acetate upon the suspected fish pathogen was determined. It was found that neither roccal nor malachite green would control the organism at the concentrations tolerated by fish, but that pyridylmercuric acetate would.

On the basis of the results of these experiments, pyridylmercuric acetate will be used experimentally, semiweekly, next season in an attempt to control the apparent bacterium that infects the blueback salmon in the fry stage.

FISH-MARKING CONTEST

A very important factor in breeding fish with those taken in open streams and lakes is the possibility of determining their age and fitness for breeding, especially if the fish used for this purpose are released again to their native elements.

How old is the trout when it breeds for the first time? How many years can it be used for breeding? Which year is likely to be most productive? When does senility begin? These and similar questions about salmonoid breeding--perhaps also about perch breeding--could be answered if we had an easy, reliable marking or branding method. It should be possible to mark or brand fish as "yearling" or "summerling," and this should be visible for 3 or even 4 years. The need is for markings which permit the recognition of each particular year, not special signs for every individual fish.

To obtain the basis for a reliable marking sign--durable but not harmful to fish--Mr. A. Nadler, owner of the Swiss Hatchery, in Aarau, Switzerland, offers 500 Swiss francs (approximately $110) to the person who, before May 1, 1951, offers the best method for "year marking" and sends his findings, a good description and photographs, to Dr. Paul Steinmann, Staatsmuseum, Aarau, Switzerland. Entries will be judged by a Commission consisting of three Members with Government participation.

Conditions: The contest closes April 30, 1951. A contestant (from any country) should place his entry in a sealed envelope showing his full name and address, and forward it to Dr. Steinmann. The winner authorizes the editors of the Schweizerische Fischereizeitung (Journal for Swiss Fisheries) to publish his paper with due acknowledgments to him.

THE TRANSFER OF ADULT SHAD

James E. Sykes
U. S. Fish and Wildlife Service
Beaufort, North Carolina

AFTER THE successful transfer of fingerling shad for a distance of 300 miles (Sykes 1950) to the Fish and Wildlife Service Laboratory at Beaufort, North Carolina, it was decided that the same method would be used to bring adult shad to the station for an evaluation of experimental tagging methods and for study of the spawning and feeding habits and growth of these fish.

For this transfer, shad taken from pound nets were used, as these fish could be expected to be in better condition for handling than those taken from gill nets. The best supply of shad was taken from pound nets located near Bath, North Carolina, 95 miles from Beaufort. One load of shad was obtained from Roe, North Carolina, but the nets there were an unreliable source of supply because they were subject to weather conditions and serviced by poor roads.

In transfer, the shad were taken from the pound nets and placed in a washtub of water. Immediately after the net was fished, the tender left for shore--a trip of about 15 minutes--and there the shad were transferred to the tank on the laboratory truck. At Bath, the tank had been filled previously with about 200 gallons of water from the same areas, and so the temperature and salinity were the same in the tank as in the river. At Roe, unfortunately, the beach and the nets were not accessible to the truck, and water had to be pumped from a nearby canal where the temperature was high and the water turbid.

The table presents the case histories of the four trips made.

FOUR TRANSFERS OF ADULT SHAD

Trip No.	Date	Source of fish	Travel history: Beginning Time	Beginning Water °F.	End Time	End Water °F.	Hours pump used	Pounds of ice	Shad hauled: Roe	Shad hauled: Buck	Shad survived: Roe	Shad survived: Buck
1	4/17	Bath, N. C.	6:00 a.m.	54.5	10:15 a.m.	56.4	1.5	0	3	3	1	2
2	4/18	Bath, N. C.	5:30 a.m.	59.1	9:50 a.m.	57.2	1.75	50	1	5	1	5
3	4/19	Roe, N. C.	12:45 p.m.	69.8	2:30 p.m.	60.8	1.0	50	4	2	1	2
4	4/25	Bath, N. C.	6:00 a.m.	57.2	9:00 a.m.	53.7	1.75	150	6	1	4	1
								Totals	14	11	7	10

This experiment is a part of the shad investigation of the Fish and Wildlife Service, an investigation which is being carried on to furnish the Atlantic States Marine Fisheries Commission with information for fishery regulations.

To summarize the results, 50 percent of the original six shad hauled on trips No. 1 and 3 survived, 71 percent of an original seven in trip No. 4 survived, and 100 percent of the six shad in trip No. 2 survived. Female shad showed poor

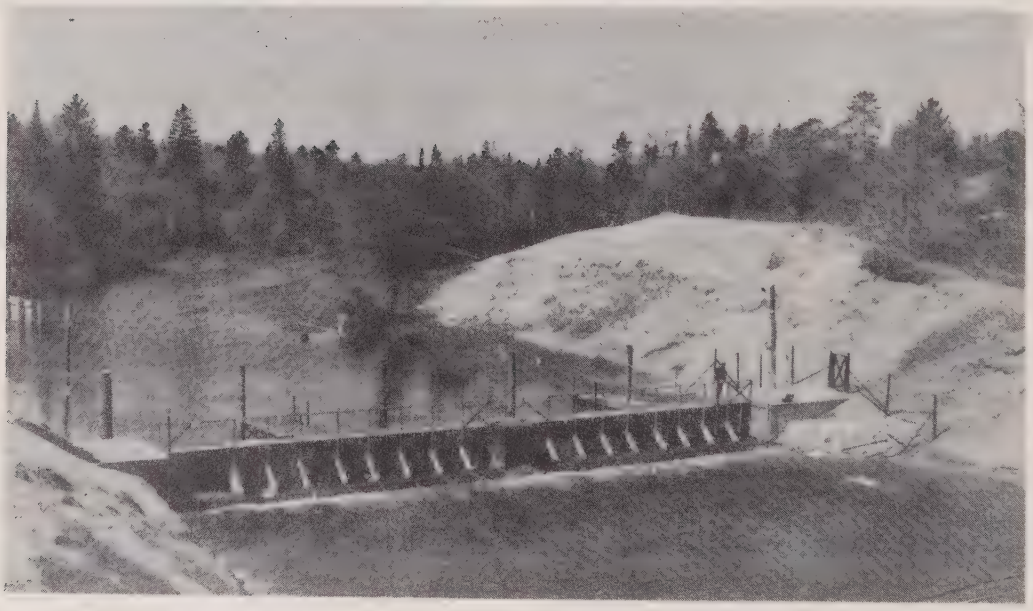
survival, only 50 percent of the 14 reaching the laboratory alive. On the other hand, 91 percent of the 11 male shad were moved successfully.

There is little apparent reason for the good survival in the second trip. Actually, the fish were on the road longer than in any of the other trips. The pump operated 40 percent of the time as compared with 35 percent for the first trip, 52 percent for the third trip, and 58 percent for the fourth. The temperature was close to the average for all trips. Finally, the success of the second trip is no doubt due in part to the composition of the load. Five of the six fish hauled were males, which are significantly hardier than females for transporting.

The results from this work upset the general opinion that it is impossible to transport adult shad or to keep them alive in confinement. We successfully moved 17 of an original 25 shad (averaging 42 centimeters in length) for distances up to 95 miles. The 17 shad remained alive and very active for some time, having completely recovered from the effects of transfer. It was not until June 3, when the water temperature exceeded 88° F., that seven of the shad died. Even though we pumped cooler well water into the ponds, we were unable to keep the water at a temperature that would permit the remaining shad to survive. By July 3, all were dead.

Literature Cited

Sykes, J. E.
1950. A method for transporting fingerling shad. Prog. Fish-Cult. 12 (3): 153-159.



Weir installed by the Fish and Wildlife Service on the Ocqueoc River, Michigan, in order to catch sea lampreys.

METAL FISH GRADERS

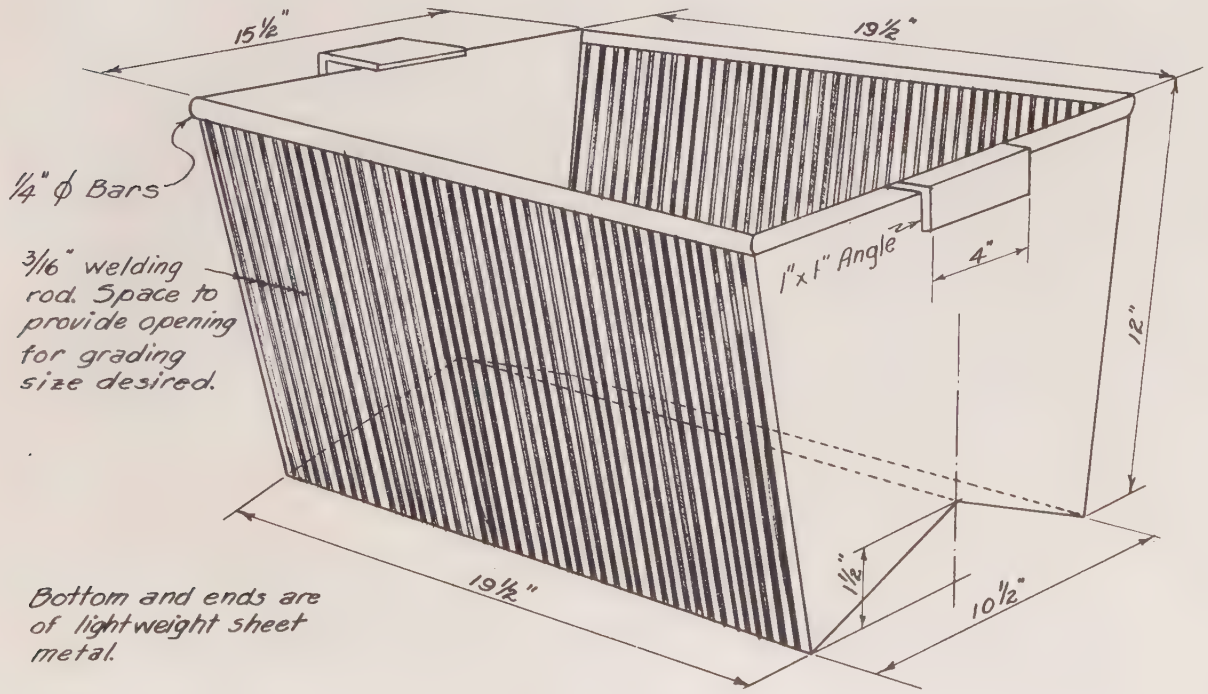
Frank A. Bengard
U. S. Fish and Wildlife Service
Austin, Texas

A SET of metal fish graders, developed for trout work, has proved very satisfactory for bass and is more effective than hand grading for bluegills.

For bass, the U. S. Fish-Cultural Station at Austin, Texas, is using three graders, each of which has openings of 1/4-, 5/16-, or 3/8-inch between the welding rods that form the sides. Aside from the size of these openings, the only difference in the three graders is that each size, as it gets smaller, is built 1/2 inch shorter and 1/2 inch narrower at the top, and 1/2 inch narrower at the bottom. This enables the hatcheryman to nest the graders and store them in a small space.

The 1/4-inch grader is 19-1/2 inches long, 15-1/2 inches wide at the top, 12 inches deep, and 10-1/2 inches wide at the bottom. The ends and bottom are of light-weight metal; the sides, 3/16-inch welding rod. The bottom has a pitch of 1-1/2 inches. (After experimentation with all types of bottom, from flat to a 45-degree pitch, a pitch of 1-1/2 inches was proved most efficient in a bottom 9-1/2 to 10-1/2 inches wide.)

The top is banded around the outside with a 1/4-inch rod. This leaves no obstruction when fish are poured from the grader. The side rods are electrically welded direct to the metal bottom at the edge and to the inside of the 1/4-inch



rods at the top. The first side rod is spot-welded at the top, bottom, and end pieces of the grader; the balance of the rods are welded to the bottom of the grader and to the 1/4-inch rod on 7/16-inch centers, leaving a 1/4-inch clearance between rods.

Pieces (4 inches long) of 1-inch angle iron are welded on the center of each end of the grader. The graders are hung by these angle irons on 1/2-inch rods placed across the tanks in the holding house. The 1/4-inch grader is put in the first tank, the 5/16-inch grader in the second tank, and the 3/8-inch in the third.

The fish, as they come from the pond, are placed in the 1/4-inch grader in the first tank. The smaller fish immediately start swimming out. To hasten the process, the grader can be rocked on the rods. When the small fish have gone through the rods, the grader is emptied into the next larger grader in the second tank, and so on. The fish remaining in the last or largest grader are then placed in a fourth tank. Thus the fish are graded to four sizes by means of three graders.

Through use of this system, all fish from a pond can be graded by the time the pond is finished. The graders are working from the time they receive the first load of fish. The graders do not need constant attention; they are just emptied from one to the other whenever necessary.

See also:

Morton, K. E.
1938. Suggestions for a fish grader. Prog. Fish-Cult. 36: 29-31.

Needham, P. R.
1935. A cheap, adjustable fish grader. (abstract) Prog. Fish-Cult. 11: 21-22.

Topel, R. C.
1947. It pays to grade--largemouth bass fingerlings. Prog. Fish-Cult. 9 (1): 40-41.

Salmon moving up the Fraser River to spawn will probably receive more assistance at Hell's Gate in the near future. It is well known that migrating fish at Hell's Gate are definitely hindered by water levels between 25 and 40 feet--and at mid-August in 1950 the river was unusually high, its levels being slightly above 40 feet. As a part of its long-term program, therefore, the International Pacific Salmon Fisheries Commission expects to construct a high-level fishway on the left bank of the river to facilitate early runs when water levels at the Gate are above 56 feet. This will complement the low-level fishway which has been operating successfully on the right bank.

PUBLICATIONS

REVIEW

HANDBOOK OF FRESHWATER FISHERY BIOLOGY

Kenneth D. Carlander

William C. Brown Company, Dubuque, Iowa.
1950. v + 281 pages. Price, $4.50.

Mr. Carlander has done an excellent job of assembling life-history data (growth, length-weight relationships, condition indices, fecundity, etc.) for more than 160 species of freshwater fishes. Readers and users of this handbook are cautioned, however, that not all the tabular life-history data are of equal value. Some represent the results of careful, detailed studies, while others are chance observations.

Limited population data (catch-per-hour, annual yield-per-acre, and standing crop of fish-per-acre) are also presented. The locations for which these data apply are cosmopolitan enough to make them useful to fishery biologists from Maine to California.

The section of conversion tables should be extremely useful. I think all fishery biologists will agree that conversion tables are a necessary evil for life-history studies, and that no two field men or field parties measure or weigh fish in the same manner. This handbook contains several good tables for converting inches (by tenths and eighths) to the nearest millimeter, or ounces and pounds to grams, as well as tables of factors for converting lengths and weights of certain preserved species to live lengths and live weights.

I believe that the most important feature of this volume is its bibliography. Apparently Mr. Carlander has expended considerable effort in assembling these original investigations, for he has compiled a bibliography of more than 1,100 references dealing with life-history studies and fishery-management problems. This feature alone makes the handbook most valuable to all who are conducting fishery investigations.

Raymond J. Buller
U. S. Fish and Wildlife Service

No human being, however great, or powerful, was ever so free as a fish.
--Ruskin.

I T 'S U P T O Y O U

Mother Nature insists upon balance--and we try to do so. Good fishing in the average farm fishpond depends largely upon stocking a suitable ratio of predator and forage fish per surface acre of fertilized water--and then maintaining a favorable balance of the populations. As the objective of THE PROGRESSIVE FISH-CULTURIST is to serve as the medium for exchange of ideas of fishery biologists and fish-culturists, to their mutual benefit, each issue of the periodical should contain a 50-50 balance of articles dealing with hatchery operations and articles dealing with fishery research and management on fresh waters. Unfortunately, we cannot print articles that we do not have.

Mother Nature abhors a vacuum--and so do we. When a farm fishpond contains no carnivorous fish, the owner will find that the forage fish are reproducing to the extent of the food resources. Similarly, when we have received fewer articles from workers outside the Fish and Wildlife Service, you will find that an issue of THE PROGRESSIVE FISH-CULTURIST contains more articles contributed by Service personnel.

Judging from the mailing list (now very close to our ceiling of 4,000 copies of each issue), we can only assume that both scientists and hatcherymen consider THE PROGRESSIVE FISH-CULTURIST a fairly good production unit, but we know that the "take" can be improved considerably. We urge you, therefore, to assist in maintaining your periodical by submitting articles dealing with your problems, techniques, and methods; your constructive criticisms of other writers' contributions; and your comments and questions.

--The EDITORS.

CLEARING HOUSE

Life history of the walleye, Stizostedion vitreum vitreum (Mitchill), in Michigan.--P. H. Eschmeyer.
Bull. 3.
99 pp., illus. 1950.

Common diseases of fish in Michigan.--L. N. Allison.
Misc. Pub. 5.
27 pp., illus. 1950.
Institute for Fisheries Research, Michigan Department of Conservation, Ann Arbor, Michigan.

Investigations of the St. Johns River and Lake Okeechobee 1948-50, with recommendations for management: a report to the director and members of the Florida Game and Fresh Water Fish Commission.--J. F. Dequine.
35 pp. August 1950.
(processed)
Game and Fresh Water Fish Commission, Tallahassee, Florida.

Indiana ponds: their construction and management for fishing.--L. A. Krumholz. Cont. No. 435. 35 pp. 1950. Lake and Stream Survey, Indiana Department of Conservation, Indianapolis; Indiana University, Bloomington, Indiana.

Fluctuations in abundance of Columbia River chinook salmon (Oncorhynchus tschawytscha) 1935-45.--R. P. Silliman. Fish. Bull. 51. (Fish. Bull., Fish and Wild. Serv., 51: 365-383) 1950. 15¢ Superintendent of Documents, Government Printing Office, Washington 25, D. C.

Holding water in farm ponds.--H. N. Holtan SCS-TP-93. 10 pp. July 1950. (processed) Soil Conservation Service, Agriculture Building, Washington 25, D. C.

Survey of the Columbia River and its tributaries - Part 3.--Z. E. Parkhurst, F. G. Bryant, and R. S. Nielson. Spec. Sci. Rept., Fisheries, No. 36. 103 pp. Sept. 1950. (processed)

Survey of the Columbia River and its tributaries - Part 4.--F. G. Bryant and Z. E. Parkhurst. Spec. Sci. Rept., Fisheries, No. 37. 108 pp. Sept. 1950. (processed)

Survey of the Columbia River and its tributaries - Part 5.--R. S. Nielson. Spec. Sci. Rept., Fisheries, No. 38. 41 pp. Aug. 1950. (processed)

Oxygen block in the main-stem Willamette River.--F. F. Fish and R. A. Wagner. Spec. Sci. Rept., Fisheries, No. 41. 19 pp. Sept. 1950. (processed) Fish and Wildlife Service, Interior Building, Washington, D. C.

Government regulations require revision of mailing lists every 6 months. In conformance with these regulations and in the interest of economy, THE PROGRESSIVE FISH-CULTURIST will be sent only to those who have a definite need or use for it. If you no longer desire to receive THE PROGRESSIVE FISH-CULTURIST, the following statement should be returned to our office:

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It is the aim of the Fish and Wildlife Service to maintain an up-to-date mailing list for THE PROGRESSIVE FISH-CULTURIST and to record promptly requests for change of address. Owing to the method of filing address cards and maintaining the addressograph plates, it is important that anyone requesting a change of address notify this office of both the old and the new address.